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LONDON, FRIDAY, JULY 4, 1941.

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H. J. PAUL, M. Inst. C.E.,
Engineer, River Ouse (Yorks) Catchment Board.

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Harrogate,
27th June, 1941. 7575

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(Sgd.) W. B. SMITH,
Secretary.
7584

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TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

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Write, stating age and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/9393. 7578 A

The Engineer

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PAPER ECONOMY

It has now become necessary, in order to maintain the normal circulation of THE ENGINEER, to print all advertisement pages on the Thin Paper hitherto used for the Foreign Edition.

So long as our diminishing stocks of thick paper will allow, the Home Edition Editorial pages will be printed on the usual paper, so that uniformity in bound volumes may be maintained.

SITUATIONS OPEN

ASSISTANT ENGINEER REQUIRED by the Government of Zanzibar Public Works and Electricity Department for one tour of 24-36 months, with possible permanency. Salary, £450, rising to £840 a year. Free passages and quarters. Candidates, age 25-35, must hold an Engineering Degree or have passed the A.M.I.C.E. Examination; have had General Civil Engineering Experience, and be specially qualified for Waterworks Supervision and Construction. A working knowledge of Electricity is desirable.

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ASSISTANT WORKS MANAGER REQUIRED for new Drop Forging Plant in the Midlands. Candidates must have had experience with the latest modern plant and must state age, full details of their career and salary required, which will be treated in strict confidence.—Address, P3373, The Engineer Office. P3373 A

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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For continuation of Small Advertisements see page 68

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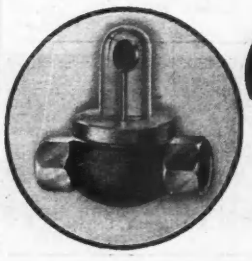
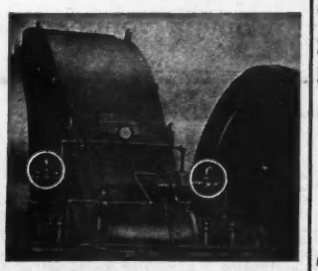
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JULY 4, 1941—VOL. CLXXII

THE ENGINEER

A Seven-Day Journal

Centenary of the Great Western Railway

MONDAY last, June 30th, marked the centenary of the opening of the completed Great Western Railway Company's main line from London to Bristol. The two sections of the line, from London to Chippenham and Bath to Bristol, had been completed the previous year, and it was on June 30th, 1841, that the line between Chippenham and Bath, with a length of close upon 13 miles, including the Box Hill tunnel of 3212 yards, was opened. On that morning a decorated passenger train left Paddington at 8 a.m. and arrived at Bristol at noon. The completion of this last section in the long run of 118¼ miles depended upon the success which attended the driving of the tunnel through Box Hill, which rises to a height of more than 400ft. above the level of the rails. Work on that tunnel was begun in 1836, and after four years was well advanced and nearing completion. The tunnel was driven from both ends, and with the aid of day and night shifts of workmen and horse transport about 250,000 cubic yards of material were removed. When just over a century ago the remaining wall of rock was pierced, the two headings were found to be exactly in line, to the great satisfaction of Isambard Brunel, the engineer, and all those engaged on that important task. It was not long after that a single track was laid which allowed the special train to pass through, piloted by Daniel Gooch, the superintendent of locomotive engines. The carriages of the first trains were unlighted, and arrangements were made for those passengers who did not like to pass through the tunnel in the dark to make the journey from Bath to Chippenham by coach. It was intended to light the tunnel by means of special reflector lamps, but when the lamps were fixed they were found to be of little use, and were abandoned.

Town Planning and Post-War Reconstruction

IN one of last week's Journal notes we outlined the report of the Civil Defence and General Purposes Committee, which was submitted to the London County Council at its meeting held on Tuesday, July 1st. The report, it will be recalled, was concerned with the evidence submitted by the Committee, on behalf of the Council, to the Expert Committee on Compensation and Betterment (Uthwatt Committee), which was appointed by the Minister of Works and Buildings, Lord Reith, in January last. The Council accepted a recommendation that written evidence on the lines of a statement prepared by Mr. Charles Latham, the Chairman of the Committee and Leader of the Council, should be submitted to the Expert Committee, and that any desired supplementary oral evidence on behalf of the Council should be given by Mr. Latham. In his speech moving the acceptance of the report, Mr. Latham stated that the evidence proceeded on the assumption that a new public spirit would demand extension of pre-war social services, and that the public interest and need must be paramount over private interest. In the first place, Mr. Latham said, it was suggested that steps should be taken to stabilise the position with regard to damaged properties, and to make it impossible for public activities, or the public purse, to be prejudiced after the war by private dealings or actions during it. He held that powers of compulsory acquisition should be largely extended, and should be made applicable without, as well as within, the county. These powers, he suggested, should be speeded up, in order to ensure that the public authority in the discharge of its duty should be helped and not hindered. The recommendation was adopted by a vote of 45 to 19.

The Douglas B.19 Bomber

ACCORDING to news from America, the new B.19 experimental bomber monoplane, which has been designed and constructed by the Douglas Aircraft Company, Inc., of Santa Monica, California, for the service of the United States Army Air Corps, left the ground on Thursday, June 26th, for the first time, when a successful trial flight was made from Santa Monica to Riverside, California, a distance of about 75 miles. According to Jane's "All the World's Aircraft, 1940," the machine has been under development for the last two and a half years, and it is reputed to be the largest aeroplane to be built in the United States. It is equipped with four 2000 H.P. Wright "Duplex-Cyclone" engines, and when taken over by the Army Air Corps will, it is expected, be used as a flying laboratory for assembling structural and technical information, which will serve as a guide to the design and construction of future very large aircraft. The machine is an all-metal low-wing monoplane, with the characteristic back-swept leading edge, associated with the Douglas D.C.2 and D.C.3 designs. It has a single fin and rudder, and is fitted with a tricycle undercarriage. The entire covering of the machine is of flush-riveted "Alclad." It is designed to carry a crew of ten, and sleeping accommodation for eight of the crew is provided. If equipped as a troop transport machine, it can carry 125 fully armed troops. The principal dimensions are as follows:—Span, 212ft.; length, 132ft.; height over rudder, 42ft. 9in.; and span of tail plane, 61ft. The diameter of the main landing wheels is 8ft. 4in., and that of the nose wheel 4ft. 6in. The weight of the bomber empty is 83,353 lb., when normally loaded 140,000 lb., and when loaded with the maximum weight 164,000 lb. Designed performance characteristics are as follows:—Maximum speed, 310 m.p.h.; cruising speed, 185 m.p.h.; and landing speed, 69 m.p.h. The B.19 has a service ceiling of 22,000ft., and a normal flying range of 7500 miles.

Staggered Working Hours

THE London and South-Eastern Regional Board announces the first comprehensive scheme for staggering working hours at industrial establishments in the London area, with the object of avoiding excessive traffic peaks, and ensuring less delay and more comfortable travelling for industrial workers. The Board consists of representatives of Government Departments concerned with armament production, employers and employees, trade unions, and transport undertakings. In investigating the problem, the Board found that in one factory area the present number of workers arriving in one half-hour was 8815, in the previous half-hour 22, and in the following half-hour 1200. Since the war began some 700 factories have adopted the staggering of working hours, with benefits to all concerned. The present comprehensive scheme, which is to be adopted, has been based on the experience thus gained. In the metropolitan area, thirty-two transport districts have been established, each comprising a number of factories, with a group leader, whose duties are to encourage and arrange, in consultation with the various firms in the group, the trade unions, and the transport undertakings, the staggering of working hours in such a manner that a uniform flow of workers' traffic to and from the area at intervals of 15 minutes is ensured. The preliminary work in connection with the new comprehensive scheme is now in progress, and it is intended to complete all arrangements in time to enable the workers in the different areas to have the full benefit of the new scheme in the coming winter months.

John Brown and Co., Ltd.

AT the annual meeting of John Brown and Co., Ltd., which was held on Friday, June 27th, in the Council Chamber of the Federation of British Industries at 21, Tothill Street, Westminster, London, S.W., Lord Aberconway, the chairman of the company, referred to the loss of H.M.S. "Hood" and her gallant officers and crew. That magnificent vessel, he said, was laid down at Clydebank in 1916, and was then the largest warship afloat, as well as the fastest capital ship. Clydebank, he continued, had every reason to be proud of her, and few ships in His Majesty's Navy had seen harder service during the present war. Her great speed and the weight of the powerful machinery which was essential for the attaining of such speed necessitated a curtailment in the weight and positioning of the armoured protection. Methods of attack, Lord Aberconway went on to say, had, however, radically changed since the building of H.M.S. "Hood," and in ships of modern design the weight and positioning of armoured protection, as well as the increased subdivision of the ship's structure, had kept fully abreast of the developments in methods of attack. From the beginning of the century Clydebank had held an outstanding position in the building and engining of the largest and most highly powered ships, and H.M.S. "Hood" might be regarded as marking a transition in development, which in recent years had produced the sister Cunard White Star Atlantic liners the "Queen Mary" and the "Queen Elizabeth." Lord Aberconway announced that during the year Sir Allan Grant, the managing director of Thos. Firth and John Brown, Ltd., had rejoined the board of John Brown and Co., Ltd. The retiring directors—Sir Allan J. Grant, Sir Thomas Bell, and Lord Aberconway—were reappointed. At the end of the meeting a cordial vote of thanks to the chairman, directors, and staff was proposed. Lord Aberconway said that although he was not permitted to give a detailed account of the work which was being carried out, which directly or indirectly was of the utmost urgency and national importance, the output which the establishments had achieved was a striking tribute to the skill and care of the management and to the energy and attention of the workpeople.

Sir William Fraser's Appointment

IT is announced that the board of the Anglo-Iranian Oil Company, Ltd., has appointed Sir William Fraser as chairman of the company, in succession to the late Lord Cadman. Sir William has had a life connection with the oil industry. He was born in 1888, and is the son of the late Mr. William Fraser, who was associated with the Pumpherston Oil Company and was one of the pioneer workers in the Scottish shale oil industry. He received his education at the Glasgow Academy, and at the Royal Technical College, Glasgow, and afterwards worked in the technical departments of the Pumpherston Oil Company. At the early age of twenty-five he was made a director of the company, and in 1915 on the death of his father he succeeded him as managing director. He took a leading part in the formation of Scottish Oils, Ltd., which company was brought into being to combine the producing and selling activities of the various Scottish shale oil producers, under the guidance of the Anglo-Iranian Oil Company, Ltd. He joined the board of that company in 1923, and in 1928 was elected its deputy chairman. His services to the nation were recognised in 1918 when he was awarded the C.B.E., and in 1939 he received his knighthood. Sir William is a director of many oil companies. His wide experience of oil production and distribution should fit him to take up the great work which was done by Lord Cadman, reference to which was made in our issue of June 6th.

The Louis E. Levy Medal

THE Committee on Science and the Arts of the Franklin Institute, of the State of Pennsylvania, announces that the Louis E. Levy Medal will this year be presented jointly to John M. Lessels and Charles W. MacGregor, on the merit of their paper and the research on which it reports. The paper, entitled "Combined Stress Experiments on a Nickel-Chrome Molybdenum Steel," was published in the August, 1940, issue of the *Journal* of the Franklin Institute. Both the recipients are Associate Professors in the Department of Mechanical Engineering at the Massachusetts Institute of Technology. The Levy Medal, we may recall, is awarded annually "to the author of a paper of especial merit, published in the *Journal* of the Franklin Institute, preference being given to one describing the author's experimental and theoretical researches in a subject of fundamental importance." It was established almost a score of years ago. John Moyes Lessels was born in Dunfermline, Scotland, on February 5th, 1888. He attended the Heriot-Watt College in Edinburgh, and received his B.Sc. degree from the University of Glasgow in 1915. From 1920 to 1931 he was manager of the mechanical division of the research laboratories of the Westinghouse Electric and Manufacturing Company at East Pittsburg. From 1931 to 1934 he was engineering manager of the South Philadelphia works, and since 1936 he has been Associate Professor of Mechanical Engineering at the Massachusetts Institute of Technology. He is also the technical editor of the *Journal of Applied Mechanics*. In 1926 he received "The Bernard Hall Prize" from the Institution of Mechanical Engineers. Charles Winters MacGregor was born in Dayton, Ohio, on May 25th, 1908, and he received his B.S. degree from the University of Michigan in 1929, his M.S. from the University of Pittsburg in 1932, and his Ph.D. from the University of Pittsburg in 1934. From 1929 to 1934 he was a research engineer with the Westinghouse Electric and Manufacturing Company at East Pittsburg. In 1934 he went to the Massachusetts Institute of Technology as instructor of mechanical engineering and was appointed Assistant Professor in 1937.

The World We Hope to Live In

By E. KITSON CLARK

THE hospitality of these pages has enabled me to put forward[1] an engineer's anxious inquiries as to his proper service to his industry and by his industry to the community. The title of that article moved in the course of its writing from "Our War Aims" to "Our Peace Aims." The attention with which it has been honoured extended its subject to a wider horizon, so that I have been encouraged to follow up with a yet bolder legend.

I have been taught that while it is the duty of a great industry to examine itself, its members should unite their concern for their own activities with their duty as citizens and try to understand the supreme issues upon which they will have to pronounce at the polls.

Therefore, two of the subjects originally suggested, namely, "Share by Employees in Management," "Share by Employees in Reward," seem to be left as problems for internal solution, though advice would indeed be welcome from some who see the situation from the outside, if only their advice were based on a serious examination of the probable operation of any scheme. But two demand the attention of engineer and citizen combined: "The Reform of our Economic System," "Production for Need and Not for Profit." "The primary cause of present evils is the failure of the economic system," are words that appear in an authoritative printed message, and as a corollary I add a sentence published in a no less important document: "It behoves every man and woman of goodwill in this crisis of the fate of civilisation without haste and without rest to work for the replacement of the existing monetary system by a national system on scientific principles in accordance with our present knowledge."[2] As an engineer looks for a recital of conditions and a specification of requirements I have asked in many quarters for an analysis of the terms "capitalism" and "vested interests," and I have at least one clear response: "As the writer has been working in the circumstances he gives for fifty years and more, if he doesn't know what the capitalistic system is, he ought to." No doubt, but the questions remain unanswered, and the writer unenlightened. Further analysis is not forthcoming, but now in the second sentence above quoted there is a definite charge against the present monetary system which we are challenged to understand.

THE MONEY SYSTEM

At the outset one asks, What is the feature of the existing system which has so sinister an influence on our national life, and so, by deduction, on its industry, and in further consequence on its engineering? And I can quote a courteous reply to a letter of mine, given to me by a distinguished scientist: "The employment of men and capital and the constructive use of all that science and invention enable to be made in raising the standard of the people could easily be secured if the control of the issue of money were entirely taken out of the power of the money-lenders and vested in Parliament advised by a scientifically constituted national monetary authority, cognisant of and paying due respect to the laws of conservation of matter and energy."

Do I go far wrong if I find in the phrase "money-lenders" above a key to a definition of "capitalistic system"?

The whole subject which is being widely disseminated is of fundamental importance and of complex difficulty, and I ask, Are we advised that we should ask ourselves the following questions? Are we to be satisfied if the visible resources by which enterprise is carried out are based mainly on credits created by banks? Are we to be satisfied if large portions of such credit represent no tangible security in the treasury of the banks, but largely rely on confidence in the future wealth to be created by the enterprise thus fortified? Are we to be satisfied that for such advances the banker should have reward by the receipt of interest? Is it the case that these advances being but cheque-credit cost the banks nothing more than book entry, and that thus they get what a young relative described after watching a conjuring trick, "a penny out of empty"? Are we to rely wholly on the banks,[3] and support the present practice without question, appreciating their courage, or do we hold that the courage is no more than the confidence due to their clients' share of the national sense of honour and stability? And do we therefore think that the security which is the asset that the nation gives should be used by the nation alone, not by privately owned commercial undertakings?

In connection with the quotation above which instigated these questions, a proposal has been made for a National Money Authority to be constituted, responsible to Parliament, through whom henceforth all increases and decreases in the aggregate of money shall alone be made, that this Authority should take over the Royal Mint and incorporate with it the function of issuing, replacing and withdrawing from circulation national notes.

A more advanced scheme for the capitalisation of the nation has been so widely and obtrusively advertised that it cannot be passed without mention. It may perhaps be well illustrated from one of certain *Monthly Messages*.[4] "A Social Credit Government is to take hold of the people's credit and issue a National Dividend." "A Social Credit Government will relieve industry and agriculture from the millstone of Bank Debt." I think this proposition also may be treated by the question test. "Are we satisfied with a programme which reads as if it were tantamount to a repudiation of obligations?" I think that last question answers itself. A reference to the earlier questions will appear later in reasoning as "to the world we hope to live in," but a part of the speculation on the subject is, in my opinion, completely removed by the editor of the *Economist* when he writes.[5] "The proper *rôle* of money is a lubricant for the economic mechanism which man's ingenuity directs and his labour drives," and "Money organised in the perfect banking system and controlled by the omniscient Central Bank could do no more than give effect to the wishes and emotions, the fears and hopes, the timidities and stupidities of Man."

In perhaps other words, the issue and withdrawal of money cannot but be made to respond to the ebbing and flowing demands of the community and may be no more wisely controlled by a national and possibly politically minded group of advisers than by individual and diversely interested bodies of bank directors. This view does not preclude the advantages which might be gained by consultation with prescribed authorities. Though there is no such simple cure as the prescription "Nationalize the Banks."

I have written on this subject, I fear, at unpardonable length with a want of trained insight, but I have observed with anxiety the hopes that our young people are deriving, without any examination, from these proposals for a change in our monetary system. Nor can it be disregarded by an engineer even when thinking exclusively of the future prospects of his industry. Allied to this distrust of the present mastery of money is the suspicion that what is called Big Business[6] is allied therewith in an unwholesome domination of all industrial undertaking, national and indeed international.

CAPITALISM

This distrust and this suspicion are, I believe, at the heart of such a memorandum as has been published this year, appearing as the considered opinion of an influential gathering of[7] those whose lives are devoted to the personal and spiritual welfare of their country.

"We believe that the maintenance of that part of the structure of our society by which the ultimate ownership of the principal industrial resources of the community can be vested in the hands of private owners may be a stumbling block to Christianity." And if to Christianity, I am sure *we* shall add, then to the true work of humanity. The meaning of this memorandum turns on the limitations implied in the word "principal." If there is no definition the statement does not help, and the practical mind cannot be satisfied with such a generalisation, but while respecting the authorship of that statement, must insist on an answer as to the stratum of our national composition in which the harm is done.

I do not know and scarcely venture to offer any opinion until the leaders of each side bring their case and countercase before the judgment of public knowledge. But I think that we might do well to remember that political reformers always require a scapegoat for the wilderness. Possibly that unblessed word "Capitalism" will serve them well, and one cannot but note that the organ of one great political party[8] has called upon the Government to be making *now* a valuation of capital upon which a post-war levy should be assessed.

In the agenda for the Labour Party's Whitsuntide Congress, 1941, appear the sentences:—"The world is now an economic unit." "Science has given us the power to lift to new and higher levels the workers' standards of life throughout the world." These are noble and true words. It is a grand programme to which everyone will subscribe and give all the service that they can. And firstly, perhaps it falls to consider the line in the manifesto signed by the Archbishops, the Cardinal and the Moderator. "Extreme inequality in wealth and possessions should be abolished." In this connection statistics have been given to me by a serious student of national affairs to mark the injustice latent in them. They are as follows:—"The National Income is absorbed in the following proportion:—

1½ per cent. of the population	22 per cent.
11 per cent. ditto	20 "
87½ per cent. ditto	58 "

And again, "The small investor may represent 75 per cent. of the total population, but his accumulated resources do not account for more than 10 to 14 per cent. of that of the whole nation. I have no source from which I can make a comment on these figures, the published statements as to the savings of all classes do not affect them, and the subject would have to be thrashed out by professional economists. But a reference may be made to a partial treatment of it by the late Lord Stamp.[9] He divides very high incomes into four classes, and for a portion of what follows I borrow his comments:—

1. *Inherited Incomes.*—This group we may dismiss as he does, with the grim note—"modern legislation seems to be taking care of the case, though it will be admitted that the result is not always happy for others besides the owners."

2. *Speculation.*—There are those who would forbid purchases on the Stock Exchange for which the buyer has not the immediate cash. But it may be maintained that the accepted value of world prices cannot be settled otherwise than by the present etiquette of the market and that the estimate of accepted value is a necessity to the individual investor and the user of material.

3. *Exploitation of Wage Earners.*—There is no defence for fortunes amassed from this source.

4. *Creating Successful Business.*—This process may introduce such advantages to the world that the wealth accruing to an individual is a price that it is well worth paying by the rest.

The inequality in itself is not a subject exactly germane to our inquiry, but as attention is drawn to it in the reformers' programme of a new economic world, we may refer to Lord Stamp again. His conviction was that a positive scheme for the definite abolition of great wealth was misconceived and reactionary on economic grounds.

Distribution would do no more to lift up the status of individuals, he said, than spreading the Alps over Europe would raise the level of the Continent. Irresponsible wealth has indeed often encouraged undesirable standards of luxury, but luxuries have involved injury to the individual rather than done harm to the generality, and should be treated by good sense rather than by legislation,

[1] THE ENGINEER, January 17th, 1941.

[2] F. Soddy, *Garvin Gazette*, "Money or Something for Nothing."

[3] The Right Hon. R. McKenna has been quoted as saying that "Up to the end of 1919 £1100 million of additional money in the form of credit was created through the medium of the joint stock banks for the purpose of financing the national effort." MEM.—Economic Reform Club to Chancellor of the Exchequer, i, xii, 39. A note follows "the creation of this new money as a process involves nothing more than additional book-keeping."

[4] For a valuable examination of this system see articles by Dr. W. H. Coates, THE ENGINEER, June 14th and 21st, 1935.

[5] "An Outline of Money," Geoffrey Crowther, Nelson, 1941.

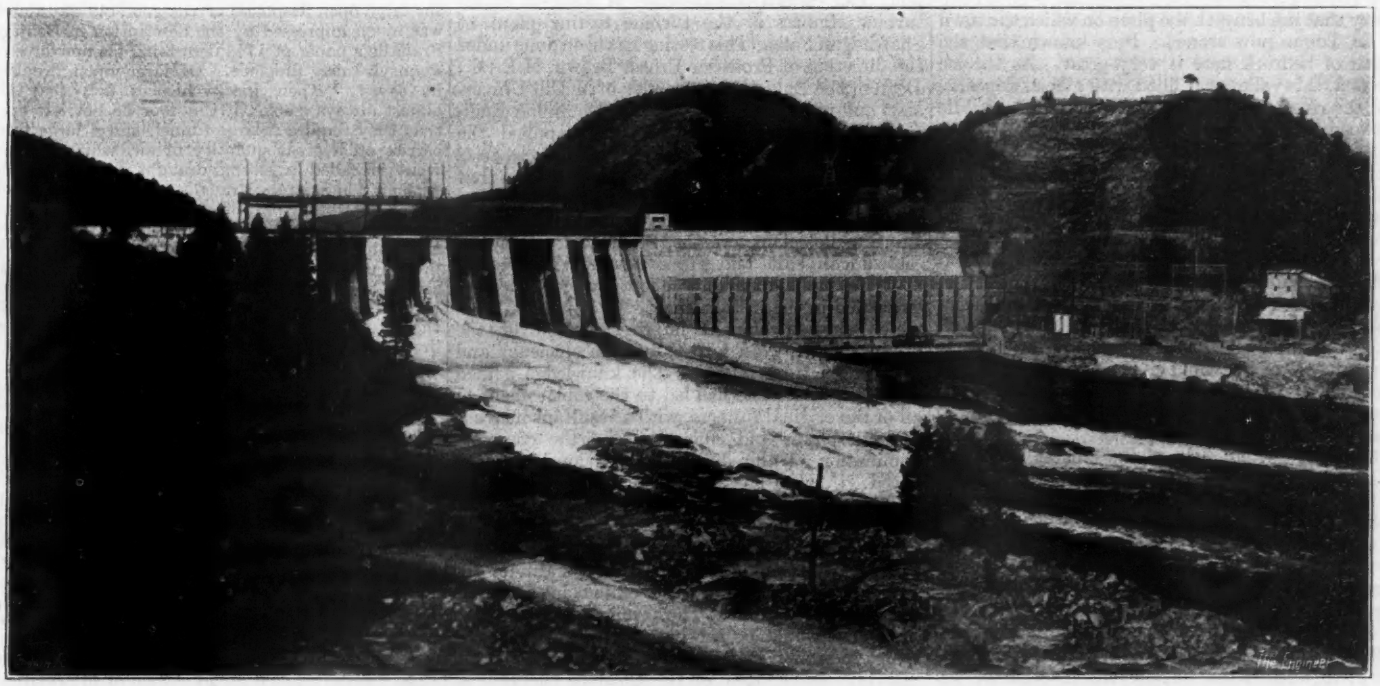
[6] The exact functions attributed to Big Business require elucidation. The following is given to me with sincere interest by a friend whose experience, success and humanity I respect most highly. The businesses which are best for the community and their own people are those whose man power does not exceed 800 or 1000. For in a firm of such a size the details of management and connection with the personnel have individual attention. There is much manufacture, he says, which requires larger installations, but he earnestly commends such an ideal where possible.

[7] The Archbishop of York's Malvern Conference, 1941.

[8] *Daily Herald*, April 8th, 1941.

[9] The *Methodist Recorder*, February 20th, 1941.

LA TUQUE HYDRO-ELECTRIC DEVELOPMENT, CANADA



while it must never be forgotten that the world is full of benefactions to great institutions made by very rich men.

Secondly, the quotation from the Party's manifesto ends with a phrase as to raising the workers' standard "throughout the world." The tremendous implications of these words involve an international co-operation and far-reaching consequences which I am afraid cannot come to be taken into account for years to come. For the time we may be content with the Anglo-Saxon speaking block, and while in these Christian countries, thank heaven, material progress is not regarded as the complete and final cause of happiness, still it is found to play a very large part in the promotion of the higher standard of living. And we ask ourselves, at once, what advance there would have been without private enterprise and how far private enterprise would have flourished without the incentive of profit.

PROFIT

So far at the end of 2000 and more words, through which we have asked the patient reader to explain to himself the unexplained propositions of reformers, we come to the real issue for the engineer and all industrialists. Are we to look upon profit out of production as right or wrong? It is, I think, a comparatively modern question; it is not long since "Fortunes made in Business" was a title expressing unquestioned commendation. Now, on the other hand, we hear from many sides of "manufacture for use, not profit," which is very much another story. I am assuming that this profit means reward over and above payment for actual services rendered or the use of capital employed, and I ask, Are there many of the instruments of our present physical life which have not been brought first into existence by men who have been moved by an innate personal ambition and an honest intention to gain means for its satisfaction? If, then, our present conditions have owed much of their well-being to individual enterprise in the past, is it conceivable that the future should be deprived of the chance of like improvements as yet unforeseen? How do we know what needs there are going to be? Who foresaw a short time ago that a domestic refrigerator was a necessity in every house; that electricity ought to be delivered to outlying houses in storage batteries? Further, if there were no profit, where is the source from which taxes, rates, endowments for religion, learning, or charities will be provided? Without profit, where could we look for even a portion of the new social services now promised without responsibility and expected without inquiry?

Manufacture by the Community for the Community is another creed. This has been found satisfactory where the market is assured—for instance, in the functions of the Post Office, the supply of water, gas, and electricity, possibly certain departments of transport, and so on—but when the market is subject to fluctuating demand, where there are the problems of export or of foreign competition, can there be any question of comparison between management by individuals whose function is responsibility and the handling by a bureaucracy whose guide to conduct is properly Safety First? There would seem to be no answers for the engineer but these—that encouragement should be given to individual enterprise; that the producer should retain possession of the instruments of his manufacture; that financial facilities which he needs and for which he can make himself answerable should not be subject to the inelastic decisions of a doctrinaire body; that he should be free to gain a due reward for his work, whether of invention, development, or supply; that he should be recognised as a good partner in the policy of the State, because he can take a risk and abide by the result. But in making these claims he must not disregard the thoughtful proposals of his fellow-citizens in this free-thinking, free-speaking land. He must be prepared to give reasons for the faiths that are in him and avoid the temptation of warmth in argument, attractive though it may be to a member of his vigorous profession. So there are many subjects to which his serious attention is due, some of which are to be found under the headings upon which I have tried to touch :—

Share by employees in management.
Share by employees in reward.
The control of the issue of money and credit.
The attitude and power of the banks.
The attitude and power of big business.
The possible use of the credit of the nation.
The relation of private ownership to the material interest of the nation.
The inequality of the incidence of wealth and possessions.
The comparison of individual management and bureaucratic control.
The province of publicly owned undertakings.
The reward of private enterprise and personal ambition.
The effect of private enterprise on material progress.

CONCLUSION

Would that we could now say, "Let us hear the conclusion of the whole matter." No one knows better than the engineer the times of stress which will come, when funds are depleted, superabundant machinery is in existence, and when workshops are installed in all parts of the world. But in spite of this, I am sure that, whatever difficulties there may be, a new spirit of the industry will lead us to aim more directly at happiness and interest for those engaged in it, and to have before us the ideal of homes[10] and lives fit for all our colleagues in its service.

It cannot but be a gradual matter, and I pray that the word "Duty" may be now added to our formula of education, and so we may help to bring about, as a poet beloved of a septuagenarian bade us do, conditions "broadening down from precedent to precedent."

Twenty centuries and more before our Laureate wrote this line, another poet-prophet, encouraging his nation in its anxious days, spoke famous words of a day of "deliverance, when old men shall dream dreams and young men shall see visions." These I borrow to-day and venture this interpretation. So shall it be with us. Our gallant young folk in their visions, unconscious of the past, will look for days when all things are generous, bright, and new, and our old men, too, will dream of a better future, but, as in a dream, will be building on the fabric of what they themselves have experienced. Thus, old and young may join in work "for a world that men may hope to live in," if only we take counsel together—Together.

La Tuque Hydro-Electric Development

No. I

AMONG the major water power projects completed in Canada in 1941 is the development at La Tuque on the St. Maurice River, in the Province of Quebec. The La Tuque development has an installed capacity of 178,000 H.P. at the point of maximum efficiency, and is capable of delivering 192,000 H.P. at full gate. It is situated 104 miles from the mouth of the St. Maurice. The river at this point flows through a narrow gorge, $\frac{3}{4}$ mile long, in which it dropped 90ft. between the upper and lower pools. Throughout the gorge the river bed was generally less than 350ft. wide between high-water marks and during periods of normal flow most of the current was confined to a deep, narrow channel that had been eroded in the bed of the river near the bank. The dam is built near the lower end of this gorge, its west abutment ending in a low corewall that penetrates the heavy layer of overburden on the west bank, and its east abutment terminating against the vertical face of a cliff that rises more than 100ft. above the top of the dam.

[10] *Cf.* THE ENGINEER, January 17th, 1941.

As with many of the power sites on the St. Maurice, the river here occupies a different channel from that followed by the pre-glacial streams that drained this region. It is apparent that before the last glacial period the river flowed through a deep valley that lies beneath the plain on which the town of La Tuque now stands. It is known that the depth of bedrock here is very great. As the ice receded, this valley was filled with glacial deposits, and the river took its new course through a saddle between the hills to the west of the buried valley and two granite knobs that protrude through the surrounding gneissic structure and from the eastern wall of the present gorge. The river quickly cut down through the glacial drift to bedrock, and then, over a long period of time, gradually carved for itself a steep, narrow channel. Glaciation and extensive faulting that has occurred in the rock of the gorge assisted the river in its work of erosion. The development of La Tuque is the fifth built on the St. Maurice since the construction of the first power-house of Shawinigan Falls forty years ago. With its completion the installed capacity of the plants on this river has reached a total of more than a million horsepower.

A partial development of the falls at La Tuque was made in 1909 by the Quebec and St. Maurice Industrial Company, predecessor of Brown Corporation. This development consisted of a wing dam at the head of the falls and a wood stave penstock leaving to the power-house at the lower end of the gorge. Two hydro-electric units of 3500 H.P. capacity at 90ft. head were installed in the power-house, and served the town and a pulp mill until 1931, when the Shawinigan Water and Power Company, in anticipation of the construction of the Rapide Blanc development, built a tranmission line from Grand' Mere.

In 1929 Mr. Hardy S. Ferguson, M.E.I.C., reported to the Brown Corporation on the complete development of the falls. In his studies he investigated seven possible arrangements of the dam and power-house. His comparative estimates showed that the most economical arrangement would be with dam and power-house situated about 600ft. above the foot of the falls. Independent studies carried out the following year by the Shawinigan Engineering Company confirmed this conclusion, and also that the site could be developed economically. An agreement was entered into between the Shawinigan Water and Power Company and Brown Corporation for a joint development of the falls, the St. Maurice Power Corporation being formed for this purpose.

Between the years 1933 and 1938, when the construction of the development was begun, further studies and investigations were carried out by the Shawinigan Engineering Company. These consisted, in general, of topographical surveys, preliminary designs and estimates, studies of methods of construction, and hydraulic studies of river flow, capacity of units and testing of model turbine runners. The topographical surveys were a continuation of the work done in 1927 and 1928 by the Brown Corporation, during which they made a detailed survey of the gorge, taking advantage of periods of low water to map exposed portions of the river bed. This topography was extended to cover all of the area above the falls that would be flooded by the construction of the development. It was apparent from a study of the data thus obtained that the highest level to which the water could be raised without causing serious damage from flooding would be El. 498, Quebec Streams Commission datum. As the pool at the foot of the falls at normal flow is at El. 384, this would provide a head of 114ft.

In studying the capacity of the units to be installed advantage was taken of the experience gained in the operation of the Rapide Blanc power-house, 30 miles above La Tuque, and of some studies of river regulation made in 1927 and 1929 by Mr. R. G. Swan, M.E.I.C., of the Water Resources Department of the Shawinigan Company. These studies indicated that a flow at La Tuque of 12,500 cubic feet per second could be depended upon for 90 per cent. of the time, and that the corresponding flow at Rapide Blanc would be 11,000 cubic feet per second. The drainage area between the two plants is 3500 square miles. A flow of 11,000 cubic feet per second at Rapide Blanc corresponds to the full-load discharge of three of the four units installed in that plant. Owing to the large volume of the Rapide Blanc pond and to the comparatively small pondage at La Tuque, it is evident that for maximum economy in the use of water the discharge of the La Tuque units should be closely correlated with that of the units at Rapide Blanc, and the full-load discharge of the units was accordingly fixed at 4200 cubic feet per second, making their capacity 48,000 H.P. at 114ft. head.

Each summer since 1929 the Shawinigan Company has carried out a series of tests of model turbine runners at the turbine testing plant at Shawinigan Falls. This testing has been done under the direction of Professor Ernest Brown, M.E.I.C., Dean of the Engineering Faculty of McGill University, and in co-operation with the Dominion Engineering Works, of Montreal, who supplied the model runners. The first objective of these tests was a study of the serious pitting and erosion that was taking place in both the runners and the throats of the propeller type turbines at the La Gabelle plant on the St. Maurice between Shawinigan Falls and Three Rivers. The results of tests made during the first two years were embodied in the installation of No. 5 unit in 1931, which showed marked improvements over the original units, Nos. 1 to 4, both in efficiency and in freedom from pitting. The knowledge gained from still later tests has led to the replacement of all of the original runners, with a resultant increase in both power and efficiency, and the complete elimination of the difficulties previously experienced.

The success that attended upon the search for an improved type of runner for the turbines at La Gabelle led in 1934 to examining the possibility of developing a propeller type runner for higher heads with the prospect of its being available for use at La Tuque. The primary advantage to be gained would be the higher speed with consequent reduction in the cost of the generators, and possibly also in that of the turbines themselves. The summer of 1934 was devoted to the testing of five propeller runners designated D 14 to D 18 inclusive. From these, D 17 was selected as having the best characteristics for heads up to 110ft. The following year complete tests of this model and of two Francis type models, D 22 and 125 B, were made. An evaluation of the relative merits of the three models was made by means of comparative estimates, taking into consideration the speeds and diameters and the cost of additional excavation made necessary by the lower setting of model D 17. These estimates showed a probable saving over D 22 in favour of both of the other models, the relative saving being the greater in the case of model 125 B. Because of this, and in view of some characteristics of the propeller runners tested that made their use for heads of 114ft. questionable, it was decided to abandon the idea of using this type, at least for the time being. Model 125 B, while high powered, had a poor cavitation characteristic and some undesirable features in the power-efficiency curve. The marked increase in speed, however, which it showed over that for D 22 led to the hope that a runner having a somewhat smaller increase of speed and more satisfactory characteristics might be evolved by further testing.

The summers of 1936 and 1937 saw more intensive testing of models of the Francis type. During this period, tests were carried out on nine different models of which all but two were eliminated, D 22, the Rapide Blanc model, and a model developed by the Dominion Engineering Works for the Gatineau Power Company and designated D 28, a higher-powered runner than D 22.

Early in the following summer two other models, modifications of D 28, designated D 30 and D 30A, were tested and found to have very satisfactory characteristics, and the latter model was chosen as the basis of the La Tuque runners.

(To be continued)

Early Application of Engineering to the Warming of Buildings*

By A. F. DUFTON, M.A., D.I.C.

In attempts to improve, it is always desirable to know exactly what progress has been made—to be able to measure the distance we have laid behind us in our advances, and also that which still remains between us and the object in view. The ground which has been gone over is easily measured; but to estimate that which still lies before us is frequently much more difficult.

RUMFORD.

IT is with a deep sense of necessity for your indulgence that I venture to address you to-day, for while in happier times I should have had the pleasurable task of browsing in the libraries and making a special study of the early applications of engineering to the art of warming buildings, such a study has unfortunately been out of the question, and the remarks which I propose to lay before you this afternoon constitute merely an essay and are based upon materials lying to hand upon my own shelves.

In the eighteenth century the usual mode of heating buildings in this country was by means of open fires. It is difficult for us to realise the inconveniences of the large open fireplaces of the good old days, and I was much impressed by the description in Benjamin Franklin's paper of 1745 describing his new-invented Pennsylvanian fireplace. Of large open fireplaces, he says: "Their inconveniences are, that they almost always smoke, if the door be not left open; that they require a large funnel, and a large funnel carries off a great quantity of air, which occasions what is called a strong draught to the chimney, without which strong draught the smoke would come out of some other part or other of so large an opening so that the door can seldom be shut; and the cold air so nips the backs and heels of those that sit by the fire, that they have no comfort till either screens or settles are provided (at a considerable expence) to keep it off, which both cumber the room, and darken the fireside. A moderate quantity of wood on the fire, in so large a hearth, seems but little; and, in so strong and cold a draught, warms but little; so that people are continually laying on more. In short, it is next to impossible to warm a room with such a fireplace; and I suppose our ancestors never thought of warming rooms to sit in; all they purposed was, to have a place to make a fire in, by which they might warm themselves when cold."

There has been some improvement since Franklin's day, but that we have not progressed very much can only be ascribed to ignorance and to apathy. Fifty years ago a valiant attempt was made to inculcate sound ideas by Douglas Galton, and in the preface to his "Observations on the Construction of Healthy Dwellings," he remarks that "the researches of the physiologist and of the medical men into the laws which govern the prevalence of diseases have enabled them by the gradual accumulation of information to lay down the principles upon which the construction of houses should rest. It is the duty of the architect, the builder, the engineer, and the surveyor to apply these principles, and their correct application is as essential to the efficient construction of a dwelling as is the quality or strength of the materials which are used to build the dwelling."

In spite of this, how seldom do we find a house in which satisfactory provision has been made for ventilation. Franklin's remark about cold air nipping the backs and heels of those that sit before the fire is generally applicable to-day. Galton's own idea was that, although the windows, when they can be kept open, are the best means for the renewal of the air in a room, every room should, nevertheless, have special inlets and outlets for air, arranged so as to be independent of the windows.

It does not cost much to install inlets for air when a house is built, and, if the incoming air is warmed by conduction from the chimney flue, very substantial economy is effected. With his Pennsylvanian fireplace Franklin reckoned to save no less than five-sixths of the fuel required to heat a room.

In securing this result he may have reduced the ventilation to a minimum. It is interesting therefore to record that about 1865 General Morin experimented with Galton ventilating fireplaces, and found that, even when the air was renewed five times in the hour, little more than one-third of the quantity of coal required by an ordinary grate was sufficient to produce the same degree of warmth.

Franklin's Pennsylvanian fireplace and Galton's ventilating fireplace were preceded by the fireplaces of Monsieur Gauger, who in 1713 published "La Mécanique du Feu," which contains a treatise on the subject, and describes a number of different constructions. This book was translated into English and published in 1716 under the title "The Mechanism of Fire made in Chimneys." Monsieur Gauger made a very notable contribution to the art of heating and ventilating, and has been reported to be the true and first inventor of the ventilating fireplace. But *vixere fortes ante Agamemnona* and Gauger himself refers us to Monsieur Savot's description of a cavity made under the hearth and behind the back of the chimney of the library of the Louvre at Paris, to point out that the air that passes therein takes but a short course, and will not sensibly grow warm.

Gauger was an observant man and full of common sense. In discussing the warmth of a room, he considered that too much attention should not be paid to the indications of a thermometer. "That those Persons are very much mistaken," he remarked, "who with an intention continually to have the same degree of Heat, would keep in their Chamber, such a one as makes the Liquor of their Thermometer rise to the same height; For if that degree of Heat were really always the same and their Thermometer were not also as uncertain as we have elsewhere observed that it is, they would almost ever feel a different Heat, accordingly as they themselves are more or less hot. . . . We are therefore to judge by our Senses of the Degrees of Heat and Cold that are agreeable to us, and not by what exteriour Objects more especially inanimate ones may represent to us; and notwithstanding that the thermometer shows us ever so fairly, that the Air of our Chamber is very hot; yet if we feel it cold, it is absolutely necessary to encrease its Heat."

It is very curious, and I do not rightly understand,

* Newcomen Society, February, 1941.

why the ventilating fireplace has never become popular. It was in use in a very simple form over 200 years ago, under the designation of the *cheminée de Nancy*, of which in 1845 Walter Beman wrote: "What a world of comfort would not this simple apparatus produce in an English cottage, as a substitute for those ache-breeding, fuel-wasting grates, with gaping flues and buried in brickwork, that throw away three fourths of the heat of all the fuel consumed in them!"

Some three years ago my wife expressed the desire that our living-room, which was warmed by an old-fashioned open fireplace, should be as well heated as her kitchen. We have contrived a ventilating fireplace, and now obtain probably three times as much useful heat from the fuel burned as before. When snow is lying on the ground, there is no difficulty in heating the room so that at a distance of 20ft. from the fire the air temperature is 70 deg. Fah.

It is of interest that in this country the use of steam as a vehicle for transporting heat for warming a room antedates the use of hot water. As early as 1784 James Watt used steam for warming the room in which he commonly wrote, and his radiator, a box 3½ft. long, 2½ft. wide, and 1in. thick, was made of tin-plates. The warming effect of this radiator, however, was less than he anticipated.

The fact that Watt's expectations were not fulfilled serves as reminder that engineering is, in a great measure, applied physics, and that practical advances follow as and when progress is made in experimental physics. We now know that the radiator of 1784 did not emit sufficient heat because of its metallic surface, but it was not until 1801 that John Leslie discovered the nature and ascertained the properties of what is termed radiant heat. His attention seems to have been directed to this problem while he was tutor to the children of Josiah Wedgewood, and no part of physical science appeared so dark, so dubious, and neglected.

He found that the application of a coat of pigment to a metallic surface, instead of retarding its discharge of heat, nearly doubled it. He remarked that this fact, equally curious and important, was most contrary to the prevalent notions, and seemed not to have been hitherto observed. He showed that a tin canister, filled with hot water, cooled considerably faster after it was covered with flannel, and required the further addition of one or two folds to make it cool at the same rate as before. "These remarkable facts," he declared, "bid defiance to the sort of loose philosophy, which, without requiring any exertion of mind, pretends to explain everything. They teach us the necessity of a sober scepticism and demonstrate the great utility of extending a critical inquiry into the various popular branches of physics."

It is perhaps not generally realised to what extent progress in the past has depended upon scientific advance or how great has been the contribution of science to heating engineering.

When we consider how the art of heating has developed we realise how fortunate the industry has been in its contacts with science. Conditions in the past were very different from those which now obtain, and much of the most valuable scientific work was carried out, not by professors or by paid research workers, but by men of affairs who studied and sought knowledge for their own satisfaction. Joseph Priestley, for example, the discoverer of oxygen, was a Nonconformist divine, and his theological writings far outweigh his scientific publications. We must recall that one of the most important contributors to the science of heat, Benjamin Thompson, was an extremely busy man. After being an Under-Secretary of State in Lord North's Government, he entered the service of the Elector Palatine and became Chamberlain, Privy Councillor of State, and Commander-in-Chief of the General Staff of the Bavarian Army. He was created Count of Rumford, in recognition of his many valued services, both military and civil.

Rumford not only made a most valuable contribution to the theory of heat, but he had always before him the importance of employing science in the service of man. He put his ideas into practice and ranks as one of the first heating engineers.

This is not the occasion for a review of his achievements, and it must suffice to indicate that he devised methods of measurement and made determinations, not only of the specific heats of various substances and the thermal conductivities of insulating materials, but also of the calorific value of fuels. On the more practical side he showed, among other things, how steam could be used for heating liquid, and in 1800 this principle was applied in the extensive dye works of Messrs. Gott and Co., at Leeds, where all the coppers were heated by steam from one steam boiler situated in a corner of one of the rooms, almost out of sight. This was a great advance upon the previous arrangement of a separate fire under each copper.

As we have already noticed, the usual mode of heating buildings in this country at the end of the eighteenth century was by means of open fires, and in this connection Rumford made notable contributions to fuel economy and showed himself the greatest "chimney doctor" of all time. It is some indication of his capacity for work that within a period of two months during a holiday in London more than 150 fireplaces were successfully altered under his direction. He was not content, however, with open fires, and he contributed to the introduction of central heating by means of steam. This was an important development, and I would like to read you a brief extract of his proposals for heating the hall of an institution:—

"When the hall which it is desired to heat is very large, and has several large windows, it is indispensably necessary to begin by making the windows double; for without this precaution the continual cooling which will take place through the single window will be so great that, no matter how much wood is burned, it will never be possible to warm the apartment uniformly throughout, and as soon as the fire ceases to burn the room will quickly become cold.

"There would be no use employing the best stoves to remedy these inconveniences. Close to the windows it will indeed be possible to feel the heat caused by their calorific radiations; but nothing can hinder the currents of air, caused by the cooling which takes place through the panes of glass, from spreading over the entire extent of the room.

"But when the windows are double, the layer of air which is enclosed between the two windows being an excellent non-conductor of heat, the inside window is well protected from cold from without and the descending currents of air just mentioned no longer existing, it would be easy, with good stoves moderately heated, to establish a pleasant and equable temperature. . . .

"As to the means of heating, it is certain, from the results of several decisive experiments, that steam stoves are preferable to every other sort, especially for large apartments. . . .

"The stove should be made of thin sheets of brass, and well soldered or brazed throughout in order to prevent the steam from forcing its way into the room; but great care must be taken not to leave the stove its metallic lustre on the outside. On the contrary, it must be painted on the outside, in order that it may diffuse more heat into the apartment. It is possible to give it the appearance of a marble or granite column, or to paint it in any other way which corresponds best on the outside with the furniture of the room. For the hall of the institute I should propose to take away three of the wooden columns which are now there, and which do not support anything, and to replace them by three copper columns of the same size and shape, and painted on the outside of the same colour. These three copper columns will be three steam stoves connected with a single boiler, which may be put in a little room on the ground floor, which happens to have a chimney, and is used at present as a sort of lumber-room where articles of small value are stored.

"In this way the hall of the Institute will be neither encumbered nor disfigured by the apparatus used for heating it in winter; and being provided with double windows of ground glass, it will be lighter and more cheerful, and at the same time more quiet, being shut off from the cheerless and disagreeable objects which surround it on every side."

Rumford's method of avoiding the effect of expansion in his steam pipes consisted of joining the pipes with a short drum of thin copper, of sufficient diameter to allow of the quantity of expansion to compress and extend it without injury. Drums, 24in. diameter, were used for joining 8in. pipes applied to warm the lecture room at the Royal Institution. Rumford devised also a contrivance for his steam apparatus, which not only served instead of a safety valve, but also prevented the apparatus from being crushed by the pressure of the atmosphere on the condensation of the steam when the fire under the boiler was extinguished or diminished.

Messrs. Boulton, Watt and Co. were responsible for a number of heating installations, and appear to have been the first to use cast iron pipes for heating. It is of interest that writing in 1845 Walter Beman made the comment: "In workmanship, modern apparatus is not equal to that erected by Boulton and Watt forty years ago. In this, as in other branches of mechanical engineering, the competition or minimum system, that at all times grinds if it should fail to ruin the workman, is most certain in its effect of debasing the quality of his work."

The firm of Boulton, Watt and Co. did not employ only the one system for heating buildings, but in each case applied the particular method which seemed best adapted to produce the desired effect; thus we find that about 1810 they installed apparatus to warm the Hunterian Museum by means of hot air upon a principle adopted by Mr. Strutt some twenty years earlier to warm his cotton works at Belper, near Derby.

In this system the air is introduced by means of ducts, and upon its way is heated by means of a cockle stove, the cockle being a dome placed over the fire, and made either of wrought iron or of rolled iron plates. In warming and ventilating the infirmary at Derby, Mr. Strutt introduced the fresh air through an underground duct, 70 yards long, with an area of 4 square feet, so that on cold days the air was appreciably warmed before it was heated by the cockle.

Mr. Sylvester used the same system for heating the lunatic asylum at Wakefield, and found that when the heating apparatus was in action the whole air of the building, equal to 400,000 cubic feet, was changed every hour.

The first use of hot water as a heating medium appears to have been in France by M. Bonnemain, who in 1777 applied it to the incubation of chickens. One item of particular interest is that in this early apparatus an expansion rod in the furnace regulated the opening and closing of the ash-pit door. The system was introduced into this country in 1816 by the Marquis of Chabannes, who in 1818 published a pamphlet describing the apparatus.

Although the Marquis was at pains to point out the undoubted advantages of hot water heating, he was quite ready to employ other methods when occasion demanded. About 1820 he chose steam as the medium for heating the House of Lords, in order to be able to regulate more easily the heat according to the number of members present. He devised a radiator in the form of a cylinder, the heating surface of which was increased by the insertion of twenty or thirty or more small pipes, open at both ends, and he called such a radiator a "calorifere."

Mention must be made of the ingenious high-pressure hot water system contrived by Mr. Perkins, which had a considerable vogue. In this system a great length, sometimes 1000ft. or more, of strong iron pipe, about 1in. in diameter, was formed into a circuit. Such tube could be laid to fit any form or succession of rooms and passages, and it was gathered into a heap or coil in the various situations where much surface was required, whether for giving out heat, as in rooms or staircases, or for receiving it, as around the burning fuel. It required neither radiators nor boiler, other than portions of itself. The system was at one time used for heating a portion of the British Museum. The temperature in the pipes varied from 220 deg. to 550 deg., but generally did not exceed 350 deg. Fah.

Mr. C. J. Richardson, who was a pupil in the office of Sir John Soane, records that Perkins' system was adopted by Sir John in his own house and museum, and makes the interesting observation that during the time of his professional duties in Sir John Soane's office he had opportunities (even without leaving it) of studying the different systems of warming, all of which, in their turn, were introduced in that building.

The tubes used for Perkins' system were of wrought iron and were ¼in. thick. They were manufactured by a process patented by James Russell and Sons, of Wednesbury. The iron was first rolled into sheets about 12ft. long of the required width and thickness, and the edges were brought nearly together. It was then heated in a furnace and the seam was welded by drawing the tube two or three times through a pair of circular nippers, which pressed the tube into the size required. The lengths of tube were screwed at each end and were tested to an internal pressure of 3000 lb. per square inch.

The installation of Perkins' system in 1833 at Strathfieldsaye for the Duke of Wellington is of interest as it was installed to keep the mansion dry and warm by the provision of heat in the corridors and staircases. The system did not warm the individual rooms, in which open fires were retained.

I have referred to Rumford as one of the experimental physicists who made practical contributions to the art of heating. He was a great experimenter. Witness this sentence: "As I foresaw, when I first began my inquiries respecting heat, that I should have occasion to make many experiments on boiling liquids, to facilitate the registering of them I formed a table (which I had printed), in which, under various heads, every circumstance relative to any common experiment of the kind in question could be entered with much regularity, and with little trouble." And did he not contrive a glass window in the wall of a furnace for the purpose "of observing the various internal motions into which flames may, by proper management of the machinery of a fire-place, be thrown, and of estimating with some degree of precision their different effects"?

Another experimental physicist who turned his attention to the important art of controlling temperature in our dwellings for the purpose of health and comfort was Dr. Neil Arnott, who was Physician-Extraordinary to Queen Victoria, and probably the greatest sanitarian of his age. He records that in 1834 that he might have constant motive and better opportunity to observe, to experiment, and to reflect upon the subject, he directed a manufacturer to fit up in his library the apparatus for warming by circulating hot water. He was not altogether pleased with the apparatus, and, in a general review of the subject, was particularly impressed by the great want, then existing, of an arrangement of fireplace by which a considerable quantity of fuel, after being lighted, should be caused, without farther interference of an attendant, to give out all the heat producible from it, as uniformly at any desired rate as a candle causes a quantity of grease or wax to give out its light or as a lamp does the same in regard to a quantity of oil.

It is strange to think that it is now 100 years since Arnott produced his gravity-fed thermostatically controlled stove and his gravity-fed self-regulating boiler. These were designed for domestic use, and the benefits derived from such appliances can only be appreciated by personal experience.

Six years ago, when I moved to my present house, I was a little exercised over the questions of labour-saving and of fuel economy, for the house is not small.† It was built 300 years ago, and as all the rooms extend the full depth of the building, they are well ventilated

† 35,000 cubic feet.

and somewhat more exposed than rooms in a modern house. My heating problem was solved by the installation of four stoves, a cooking range, and a boiler, all gravity fed with solid fuel and provided with thermostatic control. The open fire has been retained in the living-room, not merely for experimental purposes, but to provide a cheerful blaze around which the family assembles during the season of external cold and gloom.

The stoves are always alight, and in the words of Arnott: "This peculiarity, next to the saving of fuel, if not even before it, may be deemed a leading advantage of the stove, from which many minor advantages flow. Its importance is perceived by reflecting on the disadvantages of commonly interrupted fires, as—the trouble and expense, with smoke, dust, and noise, of lighting the fire every morning at least, and at other times when from carelessness or accident it has been allowed to go out—rooms becoming useless for the time when there is no fire. It is because the stove is ever alight, that the temperature of the place warmed by it is so uniform, and that so much fuel is saved. More fuel is wasted in a common grate during one morning hour, by the attempt made suddenly to raise the temperature of a room which has become cold in the night, than by keeping the fire burning moderately all night."

Arnott has long been neglected, but he was quite right, and it is difficult to understand the prejudice against automatic control. Mr. Walker, writing in 1850, remarked that because it required some nicety of adjustment, Arnott's regulator was soon abandoned by most of the manufacturers, and it is not many years ago that a President of the Institution of Heating and Ventilating Engineers "deprecated in his own practice the elaboration of automatic mechanisms because, in his view, they were not needed, and, in the second place, they were liable to get out of order. The usual fate of automatic mechanisms," he averred, "was to be shown for some time with great pride by the proprietor to his guests, but after six months he got tired of them, and they were left to rust or rot away without being touched. In normal heating work," he went on, "all that fancy work was not needed."

Nearly all the pioneers in the field of heating have felt the importance of providing healthy warm buildings for the occupation of the poor, and in 1834 Sydney Smirke, in his "Suggestions for the Architectural Improvement of the Western Part of London," records that Mr. Brunel suggested "the practicability of laying on heat to a long range of these dwellings, from one common source, a contrivance, which if perfected, would be of inestimable importance in London, where the high price of fuel is so great a burthen upon the poor."

In bringing this somewhat discursive paper to a close, I cannot help feeling not only that there are many points with which I have not dealt adequately, but also that there are some which have been neglected altogether. Of the latter, the most interesting and important perhaps is the development of boilers and their furnaces, and, in particular, the history of mechanical stoking. I am the less disturbed about this omission, however, as the subject is worthy of a special paper to the Society, and there are more competent hands than mine to write it.

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RAILWAY SALVAGE.—The London Midland and Scottish Railway has reported to the Iron and Steel Control of the Ministry of Supply that it has salvaged 110,000 tons of scrap iron and steel and reconditioned a further 10,000 tons, which in normal times would have been replaced by new material. This contribution to the war effort has been made possible through the work of the company's Redundant Assets Committee, set up prior to the war. The first survey authorised the removal of 2450 items, resulting in the recovery of about 100,000 tons of ferrous metal scrap. The subjects included sidings, crossovers and connections, over and underbridges, weighbridges and weighing machines, cabins, huts, &c., cast iron lamp standards, turntables, cranes, locomotive running sheds and railings at stations. In January, 1940, the Committee made a further survey, including all items omitted previously owing to the cost of removal being uneconomical. Since then 1000 additional items have been sanctioned for removal, some 10,400 tons of iron and steel being forwarded to the consuming works.

Some Flame Hardening Machines

IN recent years the Shorter Process Company, Ltd., has introduced a number of types of machines for the rapid surface hardening of metals, and some of these machines operate in an automatic or semi-automatic manner, and may, indeed, be ranked as precision tools. The Shorter process of hardening will be familiar to most of our readers. In brief, it is a method of hardening steel and cast iron by local heating with the oxy-acetylene blow pipe, followed by rapid water quenching from water jets. In the majority of machines there is relative motion between the blow pipe and the work. The heating rate is governed by the size of the burner and the speed of traverse and the intensity of quenching by the distance at which the quenching jets follow the burner and the flow of coolant. But in some machines the whole surface of the work is first heated and quenching is a separate consecutive operation. It is the purpose of this article to describe the machines which are illustrated by the accompanying engravings.

In the latest camshaft-hardening machines, hardening is confined only to the lobe of the cam, since the other portion is not usually subject to any load. Formerly it was the practice to harden the whole surface. All the cams on the shaft are dealt with simultaneously. The machine is illustrated in Figs. 1, 3, and 4. It is capable of hardening between thirty and fifty shafts per hour, and the operation is automatically controlled to give uniformity of treatment.

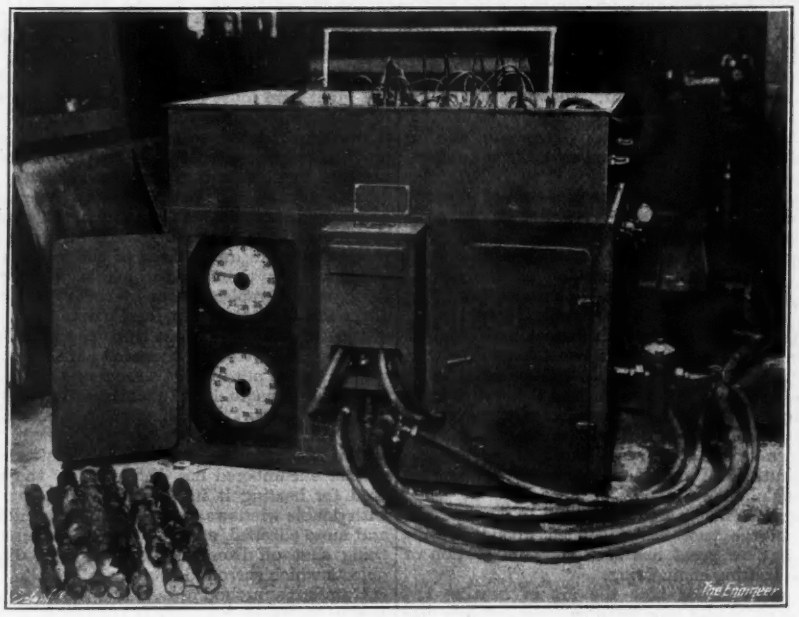


FIG. 1—CAMSHAFT HARDENING MACHINE

The machine, known as type W 1, is 5ft. 6in. long, 5ft. high, and 4ft. 6in. wide, and will take a maximum length between centres of 36in. As will be seen from the engravings, the main structure is built up from mild steel plates and angles into a box-like form. Upon this structure is mounted the machine bed carrying the head and tailstock and the locating and enclosing device. Within the tank there are two gates, each hinged on water-sealed ball bearings. Upon each gate is mounted a removable machined carrier to which are fitted a number of burner-carrier brackets, adjustable on the carrier for setting to the work piece. When a new set-up is required, the whole slide with its associated burner equipment can be rapidly removed. The burner carriers also support the blow pipes and mixing chambers leading to the burners.

The machine is fitted with two special Shorter duplex gas valves. These valves are connected to an Igranic A.C. solenoid, operated through contacts from a timing clock, by which the heating time of the operation can be predetermined and maintained or altered at will. By the same means a water valve connected to an A.C. solenoid is operated through contacts from a timing clock, so that the quenching after heating can be predetermined or altered at will. The operator presses the start button, energising the gas valve timer, and closing a pair of contacts operating the gas valve relay. When a predetermined number of seconds has elapsed the gas valve contacts open and the valve closes. The gas valve timer resets itself and simultaneously the solenoid in the water valve timer is energised, thereby closing the water valve contacts. When the predetermined quenching period has elapsed the water valve contacts are opened, closing this valve. A plunger-operated switch works in conjunction with the gates. This safety device obviates any chance of the operator accidentally starting the machine when loading.

To facilitate rapid loading and unloading of the machine, the tailstock is provided with a spring-loaded centre, lever operated. The cam lobes are positioned and located to the burners by means of a spring-loaded plunger, equipped with a slot. On the end of the camshaft is cast a small key, engaging the plunger slot and locating the camshaft angularly and correctly for hardening.

In Fig. 1 the back of the machine is illustrated, and the timing clocks and solenoid valve control box are to be seen. Fig. 3 shows a camshaft set up, and Fig. 4 the gates closed ready for the button to be pressed for automatic operation.

The machine illustrated in Figs. 2 and 7 was originally designed for the treatment of flat surfaces of any length and width, within the capacity of the unit. Recently it has been fitted with automatic

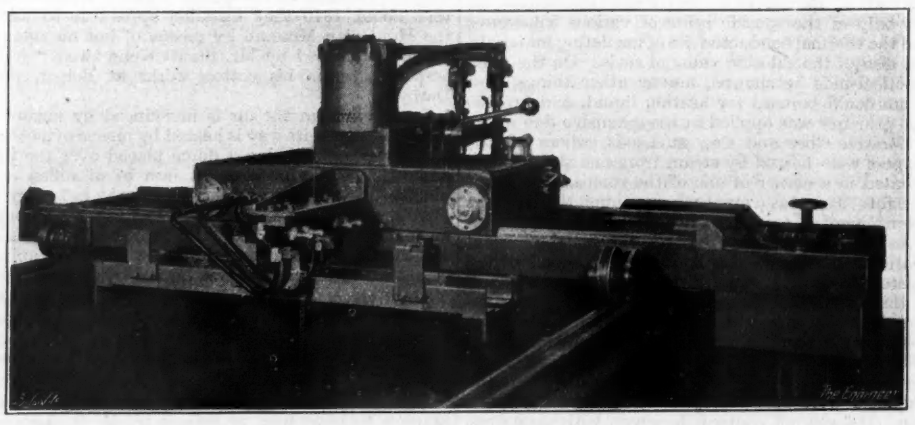
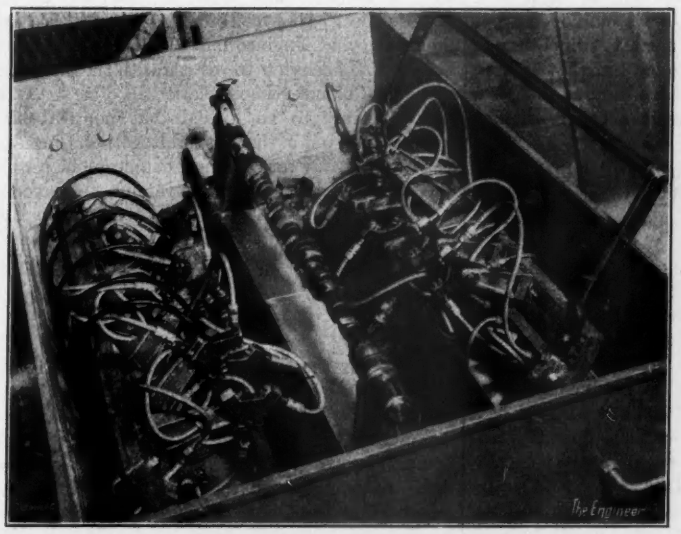
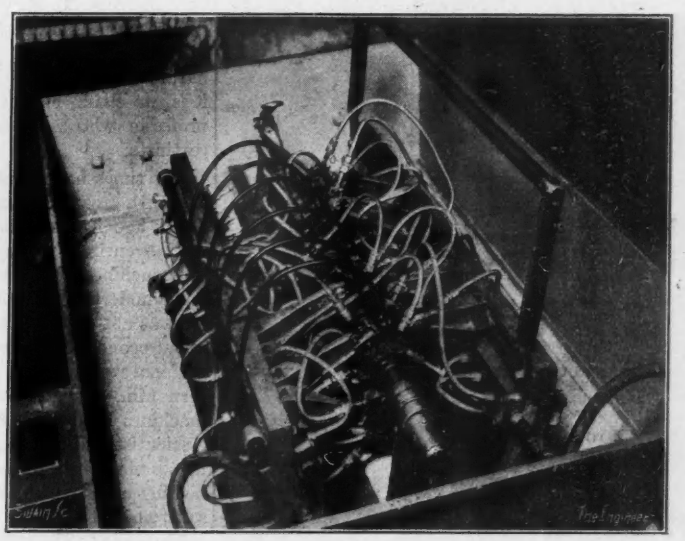


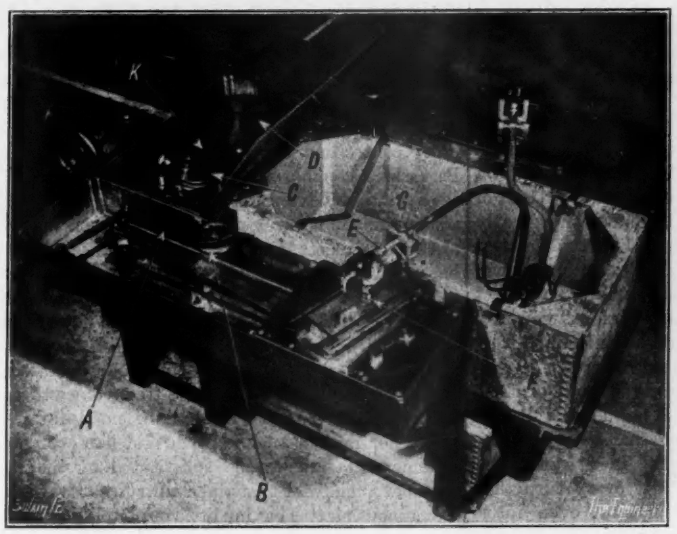
FIG. 2—AUTOMATIC SURFACE HARDENING MACHINE

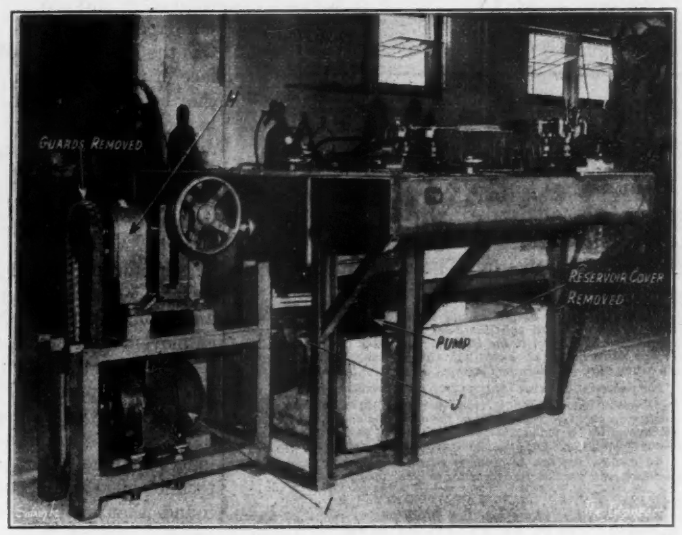
starters and trips, so that heating, quenching, and traversing are finely controlled, with the result that it is suitable for the rapid production of repetition work. The engravings show the machine set up for machine cycle can be slowed or speeded up by rotation of the hand wheel on variable speed gear H. The timing sequence of the two burners can be varied independently by suitable angular adjustment of the starts the driving motor I and lights up a red warning light. On completion of a cycle the aforementioned limit switch K cuts out the motor and also the red warning light. It will be noted that welded construc-





FIGS. 3 AND 4—CAMSHAFT HARDENING MACHINES—GATES OPEN AND CLOSED





FIGS. 5 AND 6—AUTOMATIC TWIN HARDENER WITH COVERS REMOVED

a rather unusual job, the hardening of track shoes. These shoes have two treads to be hardened, and each tread has two irregular paths so that straight-line operation is interrupted. To meet the difficulty of dealing with what is virtually a zigzag path, and to treat two paths at the same time, two standard Shorter blow pipes are provided, each feeding four heating jets. Two of the jets are on one burner and two are on the other, so that when one blow pipe only is lit, two of the jets are alight over one path to be hardened and two over the other path. Since these two pairs are linked together to one blow pipe, they can be extinguished together; similarly, the other two pairs of jets are similarly arranged. When two pairs of jets have travelled the requisite length of the path they are automatically extinguished and the other blow pipe is brought into play, and the other two pairs of jets continue the work. The controls for this operation are regulated automatically by means of trips fitted at the back of the machine.

A new fully automatic machine, shown in Figs. 5 and 6, has recently been developed for the precision surface hardening of small mass-produced components, the exact nature of which we are not permitted to disclose.

The work is mounted on a jig within the galvanised tank, and is surrounded by suitable water coolers and sprays. The burners are reciprocated successively over the work by the mechanism shown in the engravings. This mechanism is of the bell crank type, duplicated on each side of the gear-box, which is driven by a motor I through a variable-speed gear H. The stroke of the burners and coolers is variable by movement of the hand wheel B, which is in reality a variable fulcrum, and any angular displacement is effected by rotation of the burner slide F. One complete operating cycle represents a complete rotation of the timing cam C. This cam is of the variable type, and the relative times of the individual factors of a complete cycle—*i.e.*, approach, pause for initial heat, traverse of work, quenching time and withdrawal—can be altered to suit the work in hand. The whole two gear wheels D, one of which has been removed to show the variable cam and a limit switch K, which automatically cuts out the driving motor I on the completion of a cycle. On the slides F are mounted oxy-acetylene cut-off valves. These are not shown in the picture. The valves are

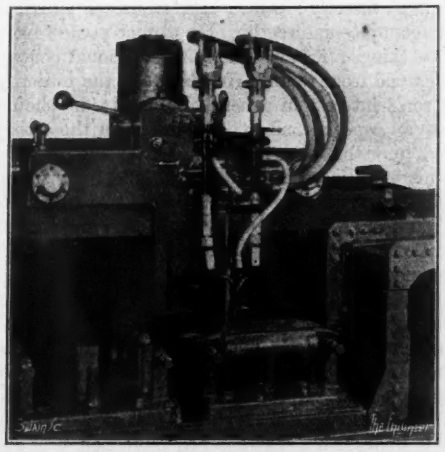


FIG. 7—SET-UP FOR HARDENING TRACK SHOE TREADS

actuated by trips arranged conveniently upon the slide base. Water pressure and supply is derived from a small centrifugal pump situated under the machine, and the electrical control is so arranged that it is impossible to start the machine until there is an ample supply of cooling water running through the burners and quenchers. A push-button switch tion has been extensively employed throughout the new machine.

BOOKS OF REFERENCE

The Motor Ship Reference Book, 1941. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 7s. 6d. net.—The seventeenth edition of this volume, which is compiled by the staff of the *Motor Ship*, has, despite difficulties associated with wartime conditions, been brought up to date, and it records many changes which have taken place in the management of motor vessels and the names of oil-engined ships. Additions have been made to the sections on new construction, and a further feature is the large number of engravings of main and auxiliary engines, which, together with drawings, give a clear picture of the modern marine oil engine. The importance of this class of ship is apparent from the statement in the preface that there are now roughly 18,000,000 gross tons of motor vessels in service, corresponding to about to 27,000,000 tons deadweight carrying capacity.

NEW INDUSTRIAL GAS GENERATOR.—A new type of gas generator for heating furnaces in steel works and other industrial plants, designed by a Swedish mechanical engineer, Mr. Axel Ohlsson, is being made by A/B Svenska Järnvägsverkstäderna. The "Parca" semi-gas furnace, as it is called, is claimed to provide practically as much heat from burning wood or peat as from coal or coke, and to have a fuel consumption about 25 per cent. lower than older wood-fired furnaces.

SCIENCE AND AGRICULTURE.—The announcement made in the House of Commons recently by the Minister of Agriculture that he had appointed a body which will be known as the Agricultural Improvement Council for England and Wales will be welcomed by agricultural engineers. The terms of reference read:—"To devise methods for seeing that promising results of research are applied as rapidly as possible to the problems of agriculture and are incorporated in ordinary farming practice; and to advise from time to time concerning agricultural problems which appear to require scientific investigation."

The Engineer

JULY 4, 1941

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A NEW WORLD

WE print to-day another article from the attractive pen of Lieut.-Colonel E. Kitson Clark. It seems to us to call for a word or two of editorial comment, for it must be confessed that in some respects it goes perilously near subjects which have hitherto been taboo in THE ENGINEER, as they are in the major engineering institutions. A technical and scientific newspaper reaches readers of a variety of political complexion, and it is therefore desirable that it should hold aloof from the turbulent arena in which political parties strive against each other. But it is barely possible for any newspaper which attempts to follow great industrial events to conceal completely its feelings and inclinations. It would be a spineless organ did it do so. We confess, if a confession be needed, that THE ENGINEER has always been an employers' paper. But that does not mean that it has been unsympathetic to the employed. We trust and believe that no one can charge it with unfairness or class bias. When it has opposed labour movements, that has been because it was convinced that the movements were economically unsound and likely to be profitable to neither of the principal parties engaged in industry. It has not so much taken sides with the employers against labour as endeavoured to lay before labour—amongst whom it is happy enough to have many readers—economic facts and principles which might have been overlooked. Classical economics is spurned nowadays by the new school of thought. That school holds that most of our social troubles are the result of the errors of the "gloomy science." It would sweep the whole science into oblivion and begin afresh. But just as a physicist must work in the light of the laws of nature as he knows them, so we employed what seemed to be the fundamental principles of natural—not formal—economics. If that is bias, it is, we claim, bias of the same kind as that of a professor who seeks to convert a colony of flat-earthists.

But times have changed in the past fifty years, and with great acceleration in the past five or ten. Years ago the mechanical engineer could devote himself entirely to the work of producing engines and machines. Even the selling of them was in the main undertaken by a non-technical department. He was not expected to bother his head overmuch about economic problems and the social and international repercussions of his industry did not concern him. It was for him to produce the best machines he could. He was wholly and solely a a scientist and technician. In those days Governments never interfered with the affairs of the engineering industry. They neither helped it to secure sales nor interposed between the owners and the workpeople. Their interest was limited to such matters as were covered by the Factory Acts. But by degrees changes began to take place, and the engineer found that he could no longer remain a pure technician. The greatest of these changes was the new attitude of the trade unions. In the face of the opposition of many of their members, they became political bodies. They made the issues between employers and employees national issues, and compelled Governments to take note of them. Then the Labour Party grew in strength and began to press for a change in the economical system of industry. Engineering was, of course, very greatly affected. Agriculture apart, it was the greatest single industry in the land. Every development of social legislation touched it nearly. To direct and control such legislation, various powerful employers' and manufacturers' organisations were set up. Thus there came into existence two parties, often with opposed objectives, and both of them endeavouring to influence the opinions of Parliament. Hence engineers found that they could no longer pursue their profession in a water-tight technological compartment. At every turn they found that political, national, and even international questions arose, and that the country was beginning to take an entirely new view of industry. Individualism, in the large sense, was being opposed by socialism, with a small *s*. The national value of industry took the place of its independent value. The engineering firm ceased to be an entity; it became part and parcel of national economy.

That is the position to-day. Willy-nilly, the engineer finds himself involved in social and political problems. Some of them affect his business directly; others—the future of banking, for example—indirectly. He cannot escape from these things; it is his duty that he should not try to escape from them. He may take the ordinary citizen's interest in general problems; he should take an especial and expert interest in those that bear upon his own industry. After the war the country will need a great deal of guidance. Many wild schemes for the regeneration of society will be advanced. Already people who should have learnt caution from past experience have made promises of a new world, doubly "fit for heroes to live in." A complete disregard of economic laws is frequently encountered. Many of the publicists and speakers are wholly unacquainted with business, and still less with the principles and practices of manufactures. Guidance will be called for. Arguments, based upon the logic of facts, will be needed. It is undesirable that the economic policy of the nation should be settled by counting heads in the House of Commons. It should be settled by reason, not by party. There is no doubt that changes must be made in accord with the spirit of the age. Engineers are as sympathetic as anyone else to improvements in the lot of the working classes. But they are more fully aware of the difficulties in their own industry than are many of the new apostles. It is their business to show these difficulties; and either to oppose changes where they would be disastrous or to indicate how they could be carried out with the least ill and the most good effects. To do this, they must be acquainted with the problems. They can no longer, we submit, hold themselves apart from the social aspirations of the times. They can no longer say, "We are engineers, and engineering alone interests us." They must endeavour to wrestle with the problems as Lieut.-Colonel Kitson Clark has done. It is very sincerely to be wished that political bias could be kept out of the matter altogether. Perhaps it can be; at any rate amongst engineers, men with scientific education, who by training and experience have learnt that the logic of events is all-powerful, and that it is only by observing them that we are able to turn natural laws to our advantage.

Glen Affric

RECENTLY there has been much reference in the Press to the scheme for the development of water power in Glen Affric, in the Western Highlands of Scotland. We have ourselves in two "Seven-Day Journal" notes given some notice to the arguments that are being urged against the project. For reasons of defence it is not permissible to publish details of the scheme of development that have been formulated. But since the objections that have been ventilated in the Press relate to the broad question whether the scheme as a whole should or should not be carried out, the details are of not very great importance for the purposes of this discussion. Briefly, the facts regarding the project may be stated as follows:—The scheme is promoted by the Grampian Power Company, a body controlling certain hydro-electric works in Perthshire, capable of developing about 57,000 kW, as a suitable extension to its works when the maximum use is being made of the power stations already in existence. At present that company has a limited reserve capacity in hand, but it is foreseen that as the demand for power grows, additional capacity will be necessary in the not distant future. Prudently therefore the company is applying now for authorisation to proceed with works in Glen Affric so that when the time comes to put the works in hand there shall be no unforeseen delay nor risk that some other and less economic scheme will have to be substituted at the last moment. The fact that the country is at war is an extraneous matter having little or no relation to the application to Parliament, which would in any case have been made at or about this time were the country still at peace. So far, the seeking for sanction for the scheme has proceeded in accordance with the normal course for Scottish schemes, except that, in view of the possibility that the enemy might glean some information of value from the evidence and arguments submitted, the meetings of the Parliamentary Commissioners appointed to inquire into the scheme were held *in camera*. Certain opponents of the scheme, it may be added here, have seized upon these secret sessions and commented upon them in such, apparently unfair, fashion that the matter has been referred to the Committee of Privileges of the House of Commons. The Commissioners found the preamble of the Order proved. In the very near future—perhaps before this issue is published—the Bill for the authorisation of the Glen Affric scheme is to come before the House of Commons, and signs suggest that opponents who have already had opportunities of voicing objections while the scheme has been taken through its earlier stages are likely now to be in full cry for its rejection.

There are, of course, always those who for one reason or another oppose the authorisation of large civil engineering schemes. Usually, however, the greater number of the objections relate to specific details of the scheme, and can be met by suitable modification or by compensation. In this case, however, the more serious opposition comes from those who wish to reject the scheme as a whole. It is contended that the proposers should not be allowed to proceed with the scheme because, so it is said, the power developed will not be used in the Highlands; because the prices likely to be levied by the promoters for power are considered

too high ; and because it is argued that it would be to the greater benefit of the inhabitants of Glen Affric and other glens in Western Scotland if each had its own individual small power development. Since a clause in the Bill submitted to Parliament requires that the power generated is to be used primarily in the " 1932 Grampian Area," the first of these objections can scarcely be upheld. For the " 1932 Grampian Area " is composed of the greater part of Invernessshire, together with the counties of Aberdeen, Kincardine, Banff, and Moray. Reservation is also made in favour of adjoining counties, such as Ross and Cromarty and Argyllshire. By far the greater part of this area lies beyond the Highland line. The other two objections hang together. The average charge per unit made by the Grampian Power Company is, we understand, about 1½d. per unit, a figure that is comparable with that ruling amongst other companies throughout this country. There is, of course, a range of charges dependent upon the nature of the demand for current. The statutory maximum charge, and one paid, it is clear, by only a very small number of the consumers, is 8d. per unit, a price which, though high, is of the same order as that made by other companies to similar consumers. It is, of course, beyond the ability of the ordinary Scots crofter to pay so high a rate. But it may be fairly remarked that even in the rural areas of England which comparatively are far more heavily populated than Highland glens, the provision of power at a cheap but economic rate constitutes a problem that has by no means been wholly solved, although numerous electrical engineers have been working at it for very many years. In the glens the problem is of correspondingly greater difficulty. It may, moreover, be added that if by the generation of power in bulk current cannot be offered at a rate low enough to prove attractive to crofters, what chance is there that small water power schemes individual to each glen could produce power any more cheaply ? To engineers the idea of thus attempting to utilise the water power of the glens separately for the sole benefit of the inhabitants of each individual glen would seem a sentimental and unpractical, even though well-meaning, attempt to return to an age of cottage industry that has long passed and would involve a regrettable wastage of great potential water power resources that would otherwise be available for beneficial distribution over a much wider area. For, quite apart from the cost of electric power, it is hardly likely that prosperity will return to the remote western glens until, amongst other matters, means of transport are so much improved that any goods produced by local industries can be economically conveyed to the markets in which they find their sales.

Had it been possible at reasonable charges to generate power in the Highlands from steam power stations, no application to Parliament would have been necessary to build the works involved. Furthermore, extensions to such steam stations could have been made as and when required without trouble. But owing to a number of factors, not the least important of which is the cost of conveying coal to a station situated in the Highlands, the generation of power in those areas can be effected more economically by hydraulic means. In the case of such water power developments, which take many years to construct, it is necessary for the controlling company to look ahead, and to obtain statutory powers to utilise watersheds well in advance of immediate requirements. The objections that are being raised to the Glen Affric scheme may be best summarised in the slogan, " Glen water power for glen inhabitants." But is it logical, either to deprive other parts of the Highlands of power altogether, or, at best, to force the Grampian Power Company to consider the erection of steam power stations, which would be less economical to operate, when close at hand there is situated a suitable potential source of water power ? The only other possible users of that source are unable adequately to develop it now or in the future, and, it may be added, will benefit as much as anyone else from the construction of the proposed works.

Obituary

CHRISTER PETER SANDBERG

RAILWAY engineers in this country, and in all parts of the world, and in particular engineers in the Far East, will learn with deep regret of the death, on June 26th at his home, West House, Crockham Hill, Edenbridge, Kent, at the age of 65, of Mr. Christer Peter Sandberg, the senior partner in Messrs. Sandberg, consulting and inspecting engineers, of 40, Grosvenor Gardens, London, S.W.1. His death creates a gap in the engineering world which it will be difficult indeed to fill. Among his many-sided interests, it is in particular his work on the steel rail and the technique of its production that will cause his name to be best remembered. That work, it may be recalled, had been initiated by his father, the late Mr. Christer Peter Sandberg, who came into prominence in this connection by reason of a paper presented in 1868 to the Institution of Civil Engineers, entitled " The Manufacture and Wear of Rails," which earned for him the Telford Gold Medal and a Telford Premium. From that time forward the firm which he founded devoted itself in large measure to improving the soundness and wearing capacity of the rail, with results which have become world-wide in their influence.

To this work Mr. Peter Sandberg's first important contribution was his patent, taken out in 1914, for the heat treatment of rails by the Sandberg sorbitic process, in order to increase their life without any sacrifice of safety. The process has since been the subject of continual development and improvement, until the regulated sorbitic treatment, as now applied, has attained a precision of result which is probably without parallel among steel heat treatments on such a mass production scale.

It is of interest to recall that during the 1914–18 war the application of the Sandberg sorbitic treatment to high-explosive shell forgings restored to serviceability millions of these forgings that had been rejected for low yield, and it may be added that the use of his process was given by Mr. Sandberg to the Government free of all royalties. A further war development was the *in situ* sorbitic treatment of tramway rails, which temporarily overcame the difficulties of replacement owing to the shortage of steel and labour, and led to 700 miles of tramway track being treated in this way. For this work Mr. Sandberg was honoured by the bestowal of the C.B.E.

The second development of note for which Mr. Peter Sandberg and his two brothers were responsible arose out of the menace of the transverse fissure in rails, which for some twenty years produced a disastrous series of rail failures and consequent derailments, more especially in North America. A close investigation of the problem by them and their expert metallurgical staff resulted in the patenting in 1928 of the Sandberg oven for controlling the cooling of rails after manufacture through that range of temperature in which fissuring is likely to take place. A complete cure was thereby effected, and the benefits of controlled cooling are now so widely recognised that it has become the standard practice of British railways, and is in almost universal use under Sandberg licence in the United States. Various other track details, in particular a steel sleeper, were the subject of Sandberg patents.

Perhaps the best example of the wide range covered by Mr. Sandberg's interests and the vision and determination that he applied to them was seen in his work on the recovery of the bullion from the P. & O. liner " Egypt," which, we may recall, was sunk in 1922 off Ushant with over a million pounds' worth of specie on board. Against the strong opinion of experts, the Admiralty included, that the wreck could not be located, and much less salved, at a depth of 400ft., Mr. Sandberg persisted in his scheme. At considerable personal expense, he succeeded first with the help of a Swedish firm in finding the wreck, and then, after several unsuccessful attempts at salvage, obtained the assistance of an Italian salvage firm, which brought up practically the whole of the gold. However great the credit due to the salvors, it is to Mr. Sandberg's courage and far-sightedness that the major tribute must be paid. Mr. Sandberg was a valued member of the Institution of Civil Engineers.

In addition to his inspection work for certain British railways, Mr. Sandberg acted as consulting and inspecting engineer for the Chinese Government Railways, the Siamese State Railways, and various colonial railways. Throughout the railway and the engineering world, no less than in the iron and steel industry, he was held in the highest esteem, and his profound knowledge and genial personality will both alike be sadly missed.

ERNEST STRAKER

THE longest day this year saw the passing, in his eightieth year, of Ernest Straker, who, although not an engineer, deserves to be remembered by us as the author of " Wealden Iron " (1931), the exhaustive, voluminous and meticulous account of the industry carried on in the Weald of Sussex for the production of iron from pre-Roman times to the end of the eighteenth century. His work was based on his own investigations, and a greater part of it was due to his own researches in the field. Mr. Straker was one of those men of whom this country has been so fruitful, who, untouched by academic distinction (Straker was engaged as a director of the Leighton-Straker Bookbinding Company, Ltd., that had its roots away back in the seventeenth century in the City of London), devote their spare time and talents to a particular line of research, and produce fundamental works.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE POINCARÉS

SIR,—Some of your Editorials have on several occasions struck me as rather " curious " for a technical paper to publish.

Be that as it may, the least I could expect from them is what any engineer might expect from the product of a machine of similar high reputation as your paper enjoys in the technical world—accuracy.

However, not content with making in past papers some sweeping assertions which it would be fairly easy to refute, you now go and " make a mathematician, Poincaré, the President of the French Republic."

Allow me, Sir, to point out that if ever there were two very dissimilar relatives, they were Henri Poincaré (the mathematician) and Raymond Poincaré, cousin of the former, who, like many another politician before and after him, was a lawyer, as far removed from the exalted spheres of exact science as could be.

There is, however, the usual grain of truth in your statement. This grain of truth is that in France engineers and *savants* have been able, owing to the place allotted them in public and social life, to rise very high in politics, &c. Two outstanding examples are Monsieur de Freycinet, an engineer (" des Ponts et Chaussées," I believe), and Monsieur Painlevé, a mathematician, who both rose to the position of Prime Minister.

Similarly, some of the greatest French military leaders started as engineers, building roads, and railways in France's Colonial Empire, the names that come here to my mind being those of Joffre and Gallieni.

C. CARTY.

Torquay, June 28th.

TECHNICAL AID TO RUSSIA

SIR,—In his broadcast on June 22nd, following the Nazi attack on Russia, the Prime Minister stated that the British Government would give technical aid to that country, which now faces the onslaught of the German war machine. It must therefore be presumed that the Government has in mind some definite plans for giving prompt and efficient technical aid from the British Empire to the Russian fighting services and their supply organisations. We learn that a British Military Mission has arrived in Moscow during the first week of the Russo-German War, and that this is shortly to be followed by others, including experts from the Ministry of Supply, who may be expected to determine the best means for giving speedy and effective technical help where it is most needed.

There will without doubt be a real demand for British engineers with technical experience of Russian methods and speaking the Russian language. These could, if required, play an important part in replacing German technical advisers, who in the last two years have increased in numbers in Russia. The matter is one which could be dealt with by a small committee of engineers meeting under the auspices of the Engineering Advisory Committee under the chairmanship of Lord Hankey, which was appointed in May of this year.

Russian engineers are as ever in need of foreign assistance in dealing with their vast problems and a

keen study and understanding of their difficulties and practical assistance will not only be appreciated by them at this time, when it will indirectly assist our own war effort, but such assistance will also lay the foundation for post-war co-operation with Russian industry.

ANGLICHANIN.

London, E.C.4, July 1st.

"COMING CRISIS IN ELECTRICAL POWER TRANSMISSION"

SIR,—Further discussion of Mr. Rissik's article and of his reply to my letter of June 11th (THE ENGINEER, June 20th) seems to be of little use so long as he ignores the elementary considerations upon which stability theory is based.

It is well known that natural load working does not solve the problem of stability, and that there are limits to the amount of power that can be transmitted between synchronous machines connected by a transmission line unprovided with special means of stabilisation.

The point at issue is whether a booster which merely inserts in the run of the line a fixed angular displacement of both current and voltage can serve this purpose. That this cannot be the case may be proved immediately if it is recalled that the stability limit is determined by the differential of the power with respect to the system angle. Altering the angle by a constant amount leaves the differential coefficient and therefore the limiting stability conditions unchanged.

In other words, the transmission of the maximum possible power over the line takes place when the difference between the no-load system angle and the load system angle is 90 deg. A static device, such as the Taylor booster, which introduces a fixed angle into the line, alters both the no-load and the load system angles by the same amount, and does not affect their difference; the magnitude of the critical power itself is not altered, but merely the corresponding value of the system angle.

C. J. O. GARRARD.

Four Oaks, Warwickshire, June 30th.

Sixty Years Ago

THE NORTH-EASTERN STEEL COMPANY

IN our issue of July 1st, 1881, we recorded that some progress was being made with the establishment of the North-Eastern Steel Company, of which S. G. Thomas, P. C. Gilchrist, A. J. Dorman, T. Wrightson and J. Denton would be among the directors. A site of land, 20 acres in extent, had been purchased at Middlesbrough, and £80,000 out of the £200,000 of capital required had already been subscribed. The works, it was intended, would in the first instance concentrate on the production of ingots, blooms, billets and tyres and would use the basic process entirely. Four converters were to be installed and the total weekly output aimed at would be 2000 tons. The birth of the company, we said, was the outcome of the efforts of those who were sanguine as to the future of basic steel. It was, however, we continued, only right to add that there were a great many others whose position and experience entitled them to respect, who considered that the commercial success of the basic process was still problematical and that the victory of steel over manufactured iron for other purposes than rails was much more so. . . . At that date Thomas had recently returned from a visit to the United States on patent business. He had met Carnegie, with whom later he became very friendly. Even before leaving for America he had conceived the idea of producing basic steel on a commercial scale. The new company was the outcome of his enthusiastic efforts to get his and Gilchrist's discovery applied in practice. Ultimately, Mr. Arthur Cooper was appointed manager of the new works and Mr. A. T. Dorman was elected chairman. Thomas at this date was already showing signs of lung trouble. In search of renewed health he visited India, Australia and other countries and returned home in July, 1883, still, however, suffering in health. He found much harassing business awaiting him and during the following winter he departed for Algiers. There, always active, he devoted much time to devising means of utilising basic slag as a phosphatic manure and to other inventions, including a new form of typewriter. He remained in Algiers until the autumn of 1884. His last seven months were spent in Paris, where he died on February 1st, 1885. He lived long enough to learn that the Germans had solved the basic slag problem by the simple process of grinding the slag and applying it directly to the land. The basic process became widely adopted on the Continent. In this country its adoption languished and eventually the North-Eastern Steel Company became incorporated in Dorman, Long and Co.

Pile Driving in Clay

By R. R. MINIKIN

OF the many problems tackled by the foundation engineer, that of driving piles into soft and medium clays is perhaps the most tantalising. Time and time again engineers have found that deductions of length-bearing capacity, made from the results of driving full-size test piles only, have not been confirmed by subsequent events. The factors bearing upon a successful solution are to be obtained only by a thorough sampling of the strata as complementary to the driving of suitable test piles. To this end several of our foremost piling firms now use more searching testing appliances which not only reduce the risks of miscalculation of earlier methods, but also reduce the cost of the preliminary testing, and form a more accurate basis upon which to fix the contract particulars of piling operations—in short, the new methods have developed a near approach to exact scientific investigation. It has the further advantage that soil mechanic principles can be applied to the accumulated data with the result that the engineer is more confident of his recommendations and predictions. Trial borings alone, even when carried out with meticulous care, only indicate the nature and physical disposition of the ground, and cannot suffice to compute the bearing capacity of a pile. They do, however, give a lead to the prediction of the probable subsequent behaviour of a pile.

There are formulæ such as that of Vierendeel, based on the friction-flotation basis of soils, but few engineers care to rely on them. The sounder methods are the direct bearing tests and the hammer-driven test piles. The modern test pile takes the form of a small-diameter steel tube, from 4½in. to 6in. diameter, fitted with a special form of detachable shoe. The shoe may be driven ahead of the outer tube by an internal mandrel to test the toe resistance, and then the outer tube can be driven to test the skin friction, or both can be driven simultaneously. The shoe may also be fitted with a smaller diameter shoe, housed concentrically in the larger shoe, so that a static load of a conveniently handled amount, or even the hammer itself, can be placed on it to test the bearing power of the ground at any required depth. There is another type of shoe fitted with a concentric retractable plug, which can be withdrawn and replaced by a sampler tube. The latter is gently forced into the ground below the shoe to gather a sample of the stratum for laboratory testing. Samples so obtained, below an impact-driven pile, are not suitable for computations of deep-lying consolidation, but they do serve the very useful purpose of computing the behaviour of the ground under heavy stresses.

For works of any importance it is advisable to investigate, by boring, the physical nature of the ground at the site to a depth of not less than twice the effective loaded width of the building, and where the strata are of several different qualities of clay, samples of such should be taken by the recognised soil mechanic method. Notwithstanding its solid appearance, clay is mobile and under pressure it becomes plastic. Its peculiar characteristics of cohesion, mobility, low permeability, and high compressibility are due to its complex microcellular structure and the presence of bound water. A clay is built up of deposited graduated colloidal grains of friable rock-forming minerals of the order of 10^{-4} cm. to 10^{-8} cm. diameter in varying degrees of compaction. The minute interstices between the colloids are filled with water strongly held by capillary action, the shape of the grains having a great influence on the water content, and, as a consequence, the mobility of the clay. The proportion by volume between the interstices or pores and the solids is termed the void ratio. A dried-out clay or one in which the void ratio is less than 0·33 is hard and will support considerable bearing pressure, but between 0·33 to 2·5 it has varying degrees of plasticity, and above a void ratio of 2·5 it becomes like porridge.

When clay is subjected to pressure the solid particles are forced closer together, the interstices reduced in volume, and the bound water is expelled. The high capillary tension in these pores requires considerable pressure to break down, and the smaller the void ratio the greater the pressure required. In actual fact, the nature of clay is such that the moisture content of a sample is not definitely indicative of its depth-pressure formation. A clay stratum may have an ancient overburden of n tons per square foot, but it does not follow that the void ratio will be that of some other clay under similar loading. This is perhaps best illustrated by an example quoted by Terzaghi of a stratum of clay underlying another, below a river bed, which had a greater moisture content than the upper stratum. These differences of behaviour are due to the shape of the colloidal particles, and therefore it cannot be taken for granted that two clays of equal void ratio and subjected to equal intensities of pressure will respond similarly. Each clay must be considered independently.

When a clay stratum is subjected to loading extra to the overburden, the bound water in the pores is extruded to the nearest permeable stratum. The influence of this active pressure is felt throughout the whole depth of the clay, and the length of the path followed by the expelled water will vary with the thickness of the clay bed. Thus, if the clay is sandwiched between two permeable strata the maximum length of path will be half the thickness of the clay, but if the latter overlies impermeable rock, the maximum length of the path will be the full depth of the clay bed. The active pressure causing the clay grains to come closer together will result in a reduction of thickness of the stratum which is reflected at the surface by a settlement of the loaded area. The minuteness of the pores, however, presents a high resistance to the flow of the contained water, so it follows that the settlement will not be immediate, but will be a

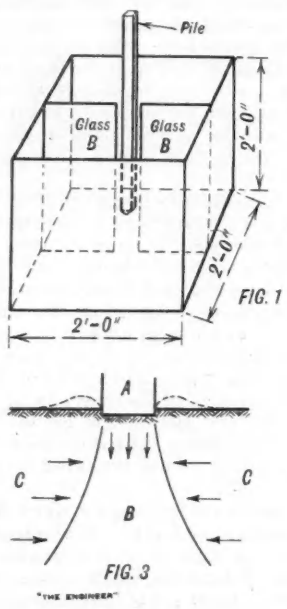


FIG. 1

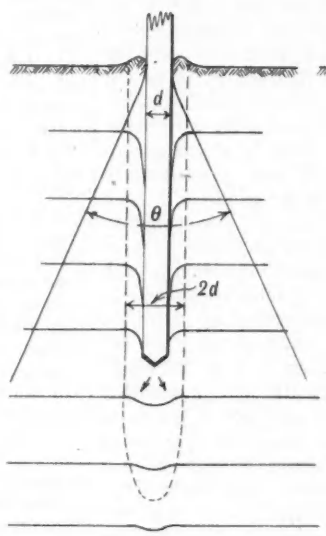


FIG. 3

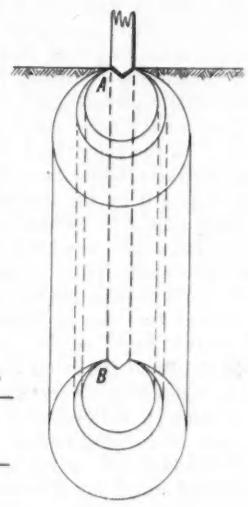


FIG. 2

FIG. 4

function of time and the permeability of the clay. It also follows that settlement will continue until the clay stratum reaches equilibrium density, and that a thick stratum will take longer to reach this density than a thin stratum; approximately the time varies as (thickness)^2. It will be appreciated that if the extra load is applied violently—such as a blow on a pile transmits to the toe—there will not be sufficient time for the bound water to be extruded naturally by the pores. A tremendous hydraulic pressure is therefore set up which disrupts the material locally, and in some clays retards the progress of the pile. Thus it is good practice in soft and medium clays to use short strokes of the hammer. This is of particular importance where the bearing capacity of the pile is calculated by the use of impact formulæ. By reason of these effects the clay closely surrounding a pile loses many of its original characteristics, and becomes to some extent foreign to the enclosing mass.

In the course of some model experiments carried out by the author on 1½in. square piles driven by a miniature piling apparatus, some interesting facts came to light. The clay was contained in a box of 2ft. cube, as shown in Fig. 1. A central partition of glass, B, divided the box into two equal compartments. The glass was in two pieces, leaving a central gap 1½in. wide. In one compartment the clay is placed in layers 3in. thick, tamped and sprinkled over the surface with powdered chalk. Successive layers are placed in a similar manner up to the top of the box, whilst the other compartment is filled up without the chalk bands. A 1½in. square pointed teak pile was then driven to a depth of 16in. in the gap between the two pieces of glass. The compartment without the chalk bands was then cleared of clay, leaving the glass panels exposed on the one side. The configuration of the chalk lines on the glass was then found to be as shown in Fig. 2. It should be remarked that the clay used in this experiment cannot be considered as representative of a natural stratum, as it is perforce in a remoulded or disturbed condition, and for that reason quantitative results are of little value. What is shown, however, is that the stratum is considerably affected in advance of the pile, and for about one diameter of the pile distance from the centre line of the pile—that is, to the boundary concentric with the pile axis shown by the dotted line in Fig. 2. Below the toe of the pile A, Fig. 3, the zone B is heavily stressed, both horizontally and vertically, whereas the surrounding zone C is only stressed horizontally. As the pile begins to enter the ground the overstressed zone B causes a plastic flow towards the zone C, which, unable to resist the heavy shear stresses, yields and causes a hump around the pile at the free surface, as shown dotted. As the pile advances, the resistance of the zone C increases, and holds the zone B in equilibrium, and simultaneously the ground immediately surrounding the pile is progressively consolidated. On the initial driving of the pile, the lines of equal vertical pressure of the bulb at the toe of the pile will be as shown at A, Fig. 4, and, as the pile advances the ground in its path will be subjected to similar pressures to the depth B. Thus, everywhere surrounding the pile there is high consolidation. There is, however, another factor which modifies the pressure distribution. The contact of the highly stressed ground around the pile becomes so intimate that the boundary of the loaded area is virtually that of a column of earth of n diameters of the pile. In the model experiments described above this column of earth was taken to be that shown by the dotted line, Fig. 2, of approximately $2d$ diameter. On this assumption the distribution of the lines of equal pressure will be as shown in Fig. 5, where at the depth B the boundary of the loaded area is that of the earth column.

After driving, the pile, being everywhere in contact with highly consolidated ground, is capable of supporting a load to the limit of the frictional resistance on its surface, and the bearing pressure at the toe. Before movement can take place, both resistances must yield. This would imply a further consolidation of the ground below the boundary of the ground already influenced by the toe. The pile will therefore settle till there is a volumetric increase of the stressed zone proportional to the increase of load beyond the static limit already reached. On the assumption that the ground is homogeneous and free from excess hydraulic conditions, the new bulb of pressure at the toe when equilibrium is reached will be identical with that before the added load was applied. Therefore it is reasonable to assume that the equilibrium has been established by the increase of the embedded length of the pile—that is, by the frictional resistance of the increased surface in contact with a newly consolidated area. It will be found that the intensity of this frictional resistance between the pile surface and the earth is greater than that usually assigned as being due to the lateral pressure of the head of earth. Sir Cyril Kirkpatrick instances 12in. by 12in. timber piles embedded 30ft. in a river bed, taking 53 tons to withdraw, and Mr. Leslie Turner, in experiments on pile drawing to obtain data for bearing resistance of a particular ground, found that 6in. by 6in. piles embedded 13ft. required a pull of 6 tons to withdraw. Mr. McHaffie found at Southampton that it was impossible to withdraw piles driven in the river bed. It can also be noticed when a pile is withdrawn that patches of highly compressed soil adhere firmly to the pile. Such experience confirms the fact that a column of earth coaxial with the pile assists considerably in the distribution of the bearing pressures into the surrounding mass of earth. This earth column may, however, be disrupted by persistent over driving or seeking to attain too small a set, particularly in wet ground.

To evaluate the bearing power of a pile from the kinetic energy of a falling weight, there are several factors which are of great importance for a successful result. They are the available energy or efficiency of the blow, the temporary compression of the pile, the plastic set, and the elastic set or ground quake. Very few of the many piling formulæ take cognisance of these factors, with the exception of the admirable formula of A. Hiley; in fact, the great majority do not even consider the weight or length of the pile. This is not scientific; indeed, by the very necessity of having to use a high numerical divisor, euphemistically termed "factor of safety," such piling formulæ really become rules of thumb. The amount of energy at the pile head available for effective driving is always some fraction of the theoretical kinetic energy of the hammer at the instant just before the blow. The considerable proportion of the energy lost is absorbed in the guides, the mechanism in friction winch plants, the heat and impact losses, the helmet, and the packing. The nature of the packing is important, as by its use the head stresses in the pile are controlled, but with the exception of a few dried-out clays and clays overlying a near compact or dense hard stratum, the head stresses, driving into clays, are not severe. Generally speaking, the weight of the hammer should be approximately one and a half times the weight of timber and steel piles, and if possible not less than half the weight of reinforced concrete piles. From a careful and comprehensive tabulation of the usual contractors' packings, and the more commonly used drop and S.A. hammers, the author finds that the following expression represents a close approximation to the available energy for driving:—

$$\left(0{\cdot}3 + \frac{W}{5P}\right)Wh \quad . \quad . \quad . \quad . \quad (1)$$

The duration of the blow on a pile is about one-hundredth of a second, and the effect is to send a compression wave of stress travelling along the pile (if reinforced concrete) at the rate of 12,000ft. per second. In clays and soft soils the toe stress is considerably less than the head stress intensity, even though a small set may be registered; but if a hard stratum underlies the clay, into which the pile penetrates, in spite of a possibly greater registered set, the toe stress intensity may approximate in value to the head stress intensity. In most cases, however, the head stress intensity is a maximum and diminishes towards the toe; indeed, in very easy driving where the toe pressure is slight, tension may develop in the body of the pile. Allowing for the elastic nature of the stressed pile, the temporary compression, in simple form, is on the average approximately $\frac{L \tan \phi}{6n}$, where L

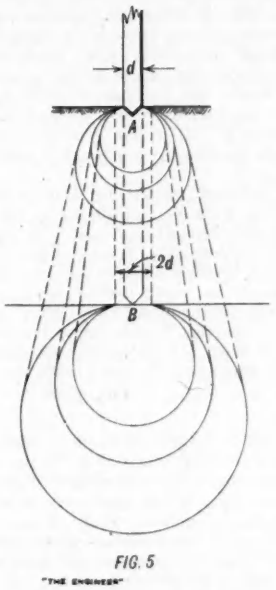


FIG. 5

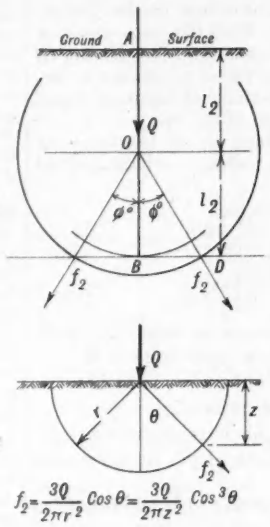


FIG. 6

FIG. 8

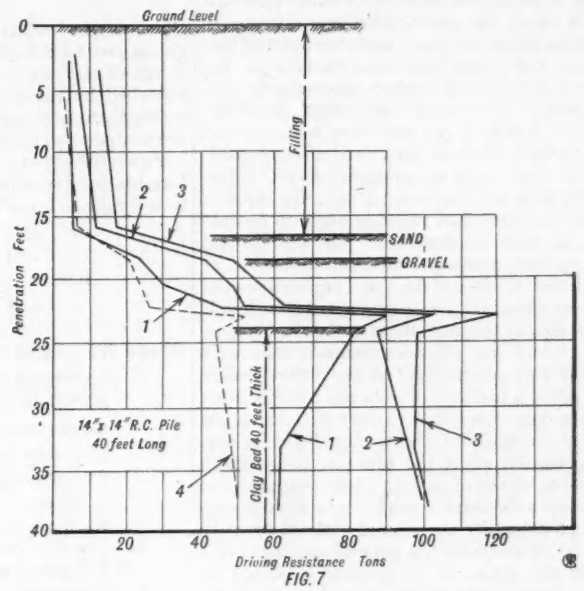


FIG. 7

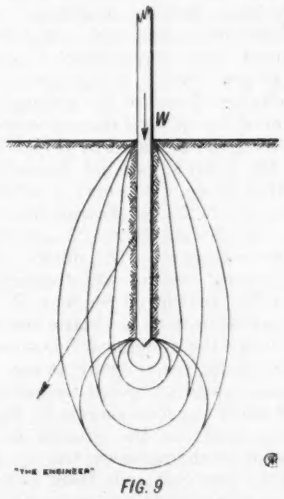


FIG. 9

$$\left(0{\cdot}3 + \frac{W}{5P}\right)Wh \quad . \quad . \quad . \quad . \quad (1)$$

is the length of the pile in inches and $n=200$ for soft and medium soils and clays and $n=100$ for hard clays and compact sands and gravels.

The set-recording diagrams commonly obtained only measure the temporary compression of the pile and the plastic set or permanent penetration. Besides this, however, there is a considerable amount of energy lost in ground vibration and lateral compression within the elastic limit. Hiley aptly calls this the quake of the ground. The author is of the opinion that the allowance made for the loss of blow energy for the quake is usually too small. As a pile is driven through the surface crust, the ground quake is considerable, particularly if the sub-stratum is soft or medium clay. In certain piling operations at Ostend the quake of the ground was noticeable on a heavy masonry quay wall 150ft. away. At Bath, brick piers in the cellar of a building 200ft. from the pile driver were noticeably vibrated, and at Barking the side of a canal was pushed forward, although some 150ft. from the pile-driving operations. It is difficult to make adequate assessments for this energy loss, but some light was thrown on the subject in the course of further experiments with the miniature pile-driving apparatus described above. The divided glass partition was replaced by a single sheet of stout glass, and the compartment filled with various qualities of soil interlarded with thin sand layers. A pile, 2in. square, was driven with one face pressing hard up against the glass, so that movement of pile and ground could be readily observed.

Confirmation of the soil drag and rupture around the pile was obtained, as in previous tests, but it was also noted, by the movement of the sand grains, that the ground was affected within a cone with apex at the surface and axis on the centre line of the pile. Over a number of tests the average apex angle of the cone was found to vary with the angle of repose of the material, the average being 54 deg. To emphasise the effect the pile was occasionally subjected to blows of a very light hammer, to approximate to the condition where the blow energy is totally absorbed by the ground without progress of the pile. Therefrom the general assumption is made that the quake of the ground is caused by the elastic deformation of the ground at about the level of the toe of the pile, and that the energy so absorbed is transmitted to the surrounding mass from the surface of the highly consolidated column of earth coaxial with the pile and of a perimeter twice that of the pile. The limit of that force is

$$Q=2\,p\,l\,f_1\tan\phi \quad . \quad . \quad . \quad . \quad (2)$$

and below the foot of the pile this force is assumed to be transmitted over a plane area bounded by the cone of stress, as described above, so that

$$Q=\pi\left(l\tan\frac{\theta}{2}\right)^2 f_2 \quad . \quad . \quad . \quad . \quad (3)$$

where Q=maximum load on the soil due to the blow,
p=perimeter of the pile,
l=embedded length of the pile,
f_1 and f_2=average intensities of stress on the respective areas,
ϕ=friction angle of soil,
θ=apex angle of cone of stress.

Then, from (2) and (3)

$$\frac{f_2}{f_1}=\frac{2\,p\,l\tan\phi}{\pi\left(l\tan\frac{\theta}{2}\right)^2}$$

$$=m\,\frac{p\tan\phi}{l} \quad . \quad . \quad . \quad . \quad (4)$$

where $$m=\frac{2}{\pi\tan^2\frac{\theta}{2}}$$

[This result may be arrived at in another way by using Boussinesq's functions. Assume that the downward force Q on the boundary plane is concentrated at and transmitted from half the embedded length of the pile, as shown in Fig. 6. Then at the boundary of the plane at the level of the toe within a cone of radius O D, making angle ϕ to the vertical axis A B, we have

$$f_2=\frac{3\,Q}{2\,\pi\left(\frac{l}{2}\right)^2}\cos^3\phi$$

inserting (2),

$$=\frac{3\times 2\,p\,l\,f_1\tan\phi}{2\,\pi\left(\frac{l}{2}\right)^2}\cos^3\phi$$

Then

$$\frac{f_2}{f_1}=m_1\frac{p\tan\phi}{l}$$

where

$$m_1=\frac{12}{\pi}\cos^3\phi\ \Big]$$

As the assumptions are based on the elastic nature of the ground, the deformations for equal lengths are

$$d_1=\frac{f_1 l}{E}\text{ and }d_2=\frac{f_2 l}{E}$$

$$\text{and}\frac{f_2}{f_1}=\frac{d_2}{d_1}$$

Then for unit deformation of the ground surrounding the pile,

$$d_2=m\,\frac{p\tan\phi}{l} \quad . \quad . \quad . \quad . \quad (5)$$

which is the relative deformation of the ground giving rise to the quake. Thus it is seen that the available energy of the hammer for driving is absorbed by the dynamic forces producing a permanent set of the pile, the quake of the ground, and the temporary compression of the pile.

From these considerations we get the following formula for the ultimate resistance of the ground to a dynamic force :—

$$R=\frac{\left(0{\cdot}3+\frac{W}{5P}\right)Wh}{s+\left(\frac{m\,p}{l}+\frac{L}{n}\right)\tan\phi} \quad . \quad . \quad . \quad (6)$$

Where W=weight of hammer in same units as P,
P=weight of pile in same units as W,
h=height of fall of hammer in inches,
s=permanent set in inches,
p=perimeter of pile in same units as l,
l=embedded length of pile in same units as p,
L=total length of pile+length of dolly, if used, in feet,
n=200 for soft and medium soils and clays,
=100 for hard clays, compact sands, and gravels,
ϕ=virtual angle of internal friction of ground (angle of repose by test). Where several different strata are traversed, the average angle in proportion to the thickness should be taken :

	Deg.
For soft ground ϕ is usually ...	25 to 30
medium ditto	30 to 38
hard ditto	38 to 45

Angle of repose	20	25	30	35	40	45
Value of m ...	3·2	2·8	2·5	2·0	1·7	1·5

For the safe load, 50 per cent. R is recommended for purely static bearing conditions, but where dynamic influences occur, such as the rise and fall of tide about piles driven into a river bed or harbour, 40 per cent. R is advisable. In Fig. 7 three graphs are shown of the driving resistance-penetration of a 14in. by 14in. reinforced concrete pile, 40ft. long, as calculated by (1) the Wellington formula, (3) Hiley's rational formula, (2) the formula given above. The curve (1) of the Wellington formula shows the safe bearing load at a factor of safety of 6, whereas curves (2) and (3) are those of ultimate resistances. The dotted curve (4) is the safe bearing load of the formula given in expression (6) ; that is, 50 per cent. R. Applying the above considerations to a static load on a single pile, and using the simplified Boussinesq expression in Fig. 8, for the pressure at any point, the distribution of pressure through the earth surrounding a pile takes the form shown in Fig. 9. This indicates a stress in the ground of elongated bulbous form extending below the toe, and shows how even in very soft soils there is a buoyancy effect set up to support a vertical load.

Electrolytic Manganese in the United States

THE development of electrolytic manganese was undertaken a few years ago by the United States Bureau of Mines, and extended laboratory studies indicated that it could be made from domestic ores at reasonable cost. As a result of these studies, the Electro-Manganese Corporation, operating under a patent assigned to the Government, undertook commercial manufacture and is now producing about 1 ton per day. According to a report by R. S. Dean, of the Bureau of Mines, the process is simple. The preferred form of manganese for introduction into the electrolyte is manganous oxide, which may be prepared from the dioxide ores. Manganese carbonate may also be used, but is less soluble than the oxide. Approximately 20 per cent. of the manganese was recovered as manganese dioxide precipitated at the anode. It could be used to oxidise the iron, but most of it had to be added at the head of the circuit and given a reducing roast. Several variations of the process have been tried, but all have the same fundamental principles.

As manufactured by the Bureau, the electrolytic manganese was extremely pure, except for 0·3 per cent. sulphur. Removal of this by treatment with borax in the molten condition, followed by removal of the boron thus introduced, is possible, but in manufacture by the company mentioned the sulphur can be kept down to 0·01 or 0·03 per cent., so that no fire refining is necessary. The product in general is 99·95 per cent. pure. Its main value is as a constituent of ferrous and non-ferrous alloys, being specially valuable as an addition to aluminium alloys. In steel making there is little difference between using blast-furnace ferro-manganese, low-carbon electric furnace ferro-manganese, or electrolytic manganese. In making low-carbon steel, some saving in open-hearth time would result, but the use of electrolytic manganese in the steel industry will depend on bringing the price down to 5d. or 7d. per lb., which, it is thought, could be done with a plant producing 50 to 100 tons daily.

However, the best market for this product, at a price at which it can be produced in small quantities, is the commercial exploitation of alloys high in manganese. Such alloys have not received attention in the past because when made from low-carbon ferro-manganese or even from silicothermic or aluminothermic manganese they have not good mechanical properties. But extensive studies of alloys made with electrolytic manganese have developed interesting and unusual properties. Characteristics of some alloys of this class are noted as follows :—

First, alloys of the manganese-copper system within the composition range 50 to 90 per cent., and with heat treatment have unusually high vibration damping capacity, which produces a remarkable deadness or lack of metallic ring. These alloys are being tested for use as noiseless gears and machine parts. Their peculiar property is associated with some unidentified constituent of the alloy that is formed by slow cooling or reheating after quenching. Similar alloys having a third element, such as nickel or zinc, retain the damping capacity and have somewhat higher mechanical properties.

Secondly, ternary alloys of manganese, nickel, and copper, with approximately 70 per cent. of manganese, have high coefficients of expansion for a metal possessing a relatively high modulus and yield point.

Thirdly, alloys of copper and manganese in the quenched state have the unusually high electrical resistance of 200 microhms per cubic centimetre. With nickel added, this resistance is slightly lowered, but the temperature coefficient of electrical resistance drops to zero. The high-manganese alloys therefore provide a group of materials having properties similar to manganin, but with higher specific resistance. Alloys of exceptionally high electrical resistance are produced by heat treatment of manganese-copper alloys containing 96 to 98 per cent. manganese. When quenched, they are ductile enough to be drawn to wire, and on heat treatment they increase greatly in resistance. But as they are then brittle, it is difficult to produce the highest resistance in fine wires. However, if these difficulties can be overcome, a new class of metallic resistors will be available, having a resistance of more than 1000 microhms per cubic centimetre.

Fourthly, manganese and nickel make an alloy brittle as glass, but with copper in addition the alloy is ductile on quenching from 900 deg. Cent. Reheating to 400–450 deg. causes substantial hardening. For example, an alloy of 35 per cent. manganese, 35 per cent. nickel, and 30 per cent. copper, when wrought and quenched, has a hardness of Rockwell C-0, but by reheating to 425 deg. Cent. for several hours the hardness reaches Rockwell C-53.

Fifthly, alloys of about 60 per cent. zinc, 25 per cent. manganese, and 15 per cent. copper lend themselves readily to extrusion, and in the extruded form have a tensile strength of more than 100,000 lb. per square inch, with substantial elongation. They possess exceptionally good machining properties, and have a bright silver colour, which is permanent in air. Other alloys with higher zinc content show promise as die castings.

Sixthly, the amount of ordinary manganese that can be added to aluminium without making it brittle is about 2 per cent. But with 8 per cent. of electrolytic manganese the alloy can be rolled into sheets.

Seventhly, alloys containing approximately 26 per cent. manganese, 18 per cent. chromium, and the balance iron have combined stainlessness and ability to harden by heat treatment. Hardening by cold work gives a maximum hardness of Rockwell C-30 ; but by heating the quenched and cold-worked material to 500–600 deg. Cent., a hardness of Rockwell C-60 may be obtained.

The Design of Condensing Plant and Cooling Water Systems*

By W. T. BOTTOMLEY, A.R.T.C., Assoc. Member

(*Continued from page 419, June 27th*)

SECTION III

COOLING TOWERS

WHEN cooling towers are used the average annual temperature of the circulating water inlet to the condenser t in Eq. (13) is not fixed, but depends on the performance and size of the tower. The fixed datum temperature for cooling towers is the average wet bulb temperature, which should be approximately the same as the average river temperature. When cooling towers are used the circulating water temperature at the inlet to the condenser is above the wet bulb temperature by an amount depending on the tower, and the vacuum temperature in the condenser is raised by the same amount. The differential $\frac{\delta T}{\delta F}$ in Eq. (3c)$=\frac{\delta t}{\delta F}$ by Eq. (13), and in order to solve Eq. (3c) it is necessary to find an expression for the differential $\frac{d t}{d F}$ for a given load in terms of the tower dimension F and the quantity of water G.

THE THEORY OF COOLING TOWERS

It is not possible here to discuss the theory of cooling towers to any great extent. Reference must be made to Merkel's article.[14] Briefly the heat is transferred from a square foot of wetted surface per hour to the surrounding atmosphere by convection and evaporation, thus :—

$$H=K\,(t-t_a)+\frac{e\,L}{p_o}\,(p-p_a) \quad . \quad . \quad . \quad . \quad (23)$$

Where e = Evaporation constant.
t and p = Temperature of the wetted surface and the corresponding vapour pressure.
$t\,a$ and $p\,a$ = Temperature of the surrounding air and the vapour pressure, corresponding to the dew point temperature.
$p\,o$ = Atmospheric pressure.

Eq. (23) may be rearranged thus

$$H=K\left[\left(t+\frac{e\,L}{K\,p_o}\cdot p\right)-\left(t_a+\frac{e\,L}{K\,p_o}\cdot p_a\right)\right]$$

Merkel showed that $\left(t+\frac{e\,L}{K\,p_o}\cdot p\right)$ is proportional to the heat content of the mixture of air and vapour saturated at temperature t—compare with Eq. (25) below.

Therefore $H=c\,K\,(I-I_a)$, where c is a constant.

When the wetted surface is at the atmospheric wet bulb temperature, then equilibrium is established, and there is no net flow of heat. Therefore $I_B=I_A$, where I_B is the heat content of the air saturated at the wet bulb temperature.

This is in accordance with the principle of wet bulb hygrometry.

The net result is that with cooling towers the heat transferred is proportional to the mean I difference instead of the mean temperature difference as for condensers.

The final result of Merkel's investigation is given by the following equation in terms of the tower constants :—

$$\alpha=\frac{I_m-I_a}{x}=\alpha_o+\alpha_1\frac{G}{F}=\alpha_o+\alpha_m\frac{W}{F\,x} \quad . \quad . \quad . \quad (24)$$

Where F is the rainfall area at the base of the tower, and α, α_o, α_1, and α_m are constants depending on the design of the tower and which are determined by tests. I_a is the heat content of the atmospheric air per lb. entering the tower, as indicated by the wet bulb temperature, and I_m is the mean heat content of saturated air per lb. at the water temperature taken over the cooling range.

The heat content of the air at different wet bulb temperatures is given by the following :—

$$I=0\cdot24\,(t_B-32)+\frac{0\cdot625\,L\,p_B}{p_o-p_B} \quad . \quad . \quad (25)$$

Where t_B is the wet bulb temperature, p_B is the vapour pressure corresponding to the wet bulb temperature, p_o is the atmospheric pressure, and L is the latent heat. The pressures are given in absolute units. The heat content given excludes the sensible heat in the liquid.

The relation is shown in Fig. 4.

I_m in Eq. (24) is obtained by Merkel by step-by-step method from the following integration :—

$$I_m=\frac{1}{t_1-t}\int_t^{t_1} I\,d\,t \quad . \quad . \quad . \quad . \quad . \quad (26)$$

Where t_1 and t are the temperatures of the water entering and leaving the tower, I_m is plotted for constant recooled temperatures against the cooling range in Fig. 10. To determine the value of the constants α_o and α_m in Eq. (24), a special test was carried out at the author's suggestion on the concrete hyperbolic cooling tower at Haughton Road power station, Darlington, to show the effect on the water temperatures entering and leaving the tower if the water was throttled at constant load. The results of the test are given in Table II.

The result of this test on the tower constant is shown in Fig. 11, and indicates that the value of the constants α_o and α_m in Eq. (24) are 0·5 and 1·0 respectively. On the same tower tests were carried out under normal operation on sixty different days during this winter and last summer. The wet bulb readings ranged from 33 deg. to 64 deg. Fah., humidities from 56 to 96 per cent., and loads on the turbine varied from 15,000 kW to 20,000 kW. As the quantity of water was practically constant, these sixty tests give results all in the same region in Fig. 11. According to Merkel the value of α_m should increase with the wet bulb temperature, but the evidence from these tests indicate α_m to be constant. The tests do not indicate any effect on the constants due to varying humidity at constant wet bulb temperature. The tower at Darlington is 125ft. high, 96ft. 4in. diameter at the base, with a static lift to the hot water trough of 25ft.

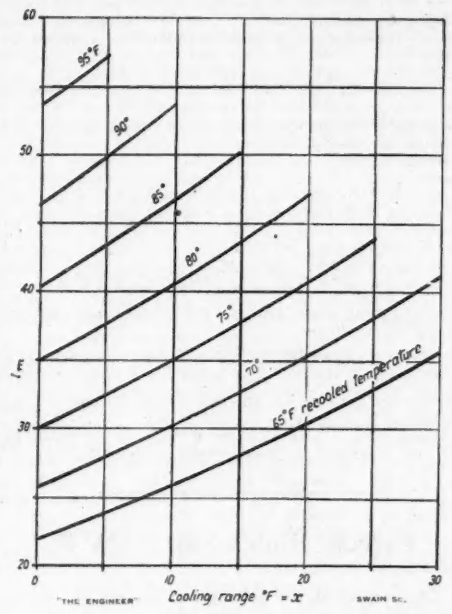


FIG. 10—*Cooling Tower Data*

It appears from the evidence available that Eq. (24), with the values of the constants indicated in Fig. 11, represents very well the performance of concrete cooling towers of the hyperbolic type, as they are designed at present for power stations.

The form of Eq. (24) in terms of I_m is, however, inconvenient for finding the differential $\frac{\delta T}{\delta F}$ or $\frac{\delta t}{\delta F}$ for Eq. (3c), but it can be put in terms of the recooled temperature of the water, thus :—

$$I_m-x/2=W/F+I_A \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

and

$$t=f\left(I_m-\frac{x}{2}\right)$$

assuming that $\alpha_o=\frac{1}{2}$ and $\alpha_m=1$ where t is the recooled water temperature.

The term $(I_m-x/2)$ in Eq. (27) is plotted in Fig. 12 against x. If x is nil, then $I_m-x/2=I$, which is the heat in the saturated air at the temperature of the recooled water. When x is not nil it will be found by examining Fig. 12 that the value of $(I_m-x/2)$ is very little affected by the value of x within the range of cooling tower operation, which explains why in the throttling test at Darlington the recooled temperature was not affected by the increased cooling range at constant load. It is therefore possible to plot Eq. (27) as a single curve showing the relation between the recooled temperature and the term $(W/F+I_A)$, which is practically independent of the cooling range, as shown in Fig. 5. This curve should give the performance of any size tower of the hyperbolic type within the practical range of operation. The curve in Fig. 5 is actually drawn for a cooling range of 15 deg. Fah.

Some of the Darlington test results are shown in Fig. 5, and also the test results at Hams Hall[15] and Klip.[15]

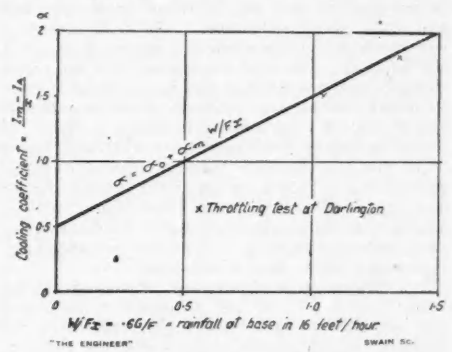


FIG. 11—*Hyperbolic Cooling Towers. General Characteristic Curve giving Relation between the Cooling Coefficient and the Rainfall at the Base*

NOTE.—The unit scale in the abscissa also represents 100 gallons per hour per square foot base area.

For determining the economic size of tower we are only concerned with the recooled water temperature region within 70 deg. and 80 deg. Fah., and within this region the curve in Fig. 5 can be represented by a straight line, the equation for which is

$$t=47+\frac{1}{1\cdot1}\,(W/F+I_A)$$

Therefore

$$\frac{\delta t}{\delta F}=-\frac{1}{1\cdot1}\frac{W}{F^2}=\frac{\delta T}{\delta F} \quad . \quad . \quad . \quad . \quad (28)$$

EFFECT OF THE TOWER ON THE POWER FOR PUMPING

The effect of the tower on the power for pumping is that due to the static lift to the hot water trough. There appears to be some uncertainty whether the height of the trough is affected by the size of the tower. The static lift for the 125ft. tower for Darlington is 25ft., but for the 210ft. tower at Hams Hall the static lift is about 35ft. The designers have assured the author that the static lift is not affected by the size of the tower, in which case the differential $\frac{\delta P}{\delta F}$ in Eq. (3c) is nil.

TABLE II.—*Test on Concrete Cooling Tower to Find the Effect on the Vacuum of Reducing the Water Flowing Over the Cooling Tower.*

Date, Thursday, September 5th, 1940.

During the test the load was kept steady at 17,000 kW from 9 a.m. to 4 p.m. and from 9 p.m. to noon the quantity of water flowing over the cooling tower was 1,000,000 gallons per hour, and from noon to 4 p.m. 816,000 gallons per hour.

Time.	Load, mWs.	Vacuum, in. Hg.	Circulating water, temperatures deg. Fah.		Hygrometer, deg. Fah.	
			Inlet.	Outlet.	Wet.	Dry.
9.0	17	27·9	95·0	81·5	59·0	62·0
9.30	17	27·8	95·2	82·0	59·5	62·2
10.0	17	27·85	96·0	82·5	59·5	63·0
10.30	17	27·8	96·0	82·5	60·0	63·5
11.0	17	27·8	96·2	82·0	60·0	64·0
11.15	17	27·8	96·0	82·0	62·0	66·2
11.30	17	27·8	96·0	82·0	63·0	68·5
11.45	17	27·8	96·0	82·0	62·5	68·2
Noon	17	27·8	96·0	82·0	63·0	68·5
12.30	17	27·6	99·0	81·0	62·0	68·0
13.0	17	27·55	99·0	81·0	62·0	68·2
13.30	17	27·55	99·0	81·0	62·0	68·5
14.0	17	27·52	99·0	81·0	62·0	69·0
14.30	17	27·52	99·5	81·0	62·0	70·0
15.0	17	27·6	99·5	82·0	60·5	68·0
15.15	17	27·45	100·0	82·0	61·0	68·5
15.30	17	27·5	100·0	82·0	61·0	68·5
15.45	17	27·47	100·5	82·0	60·5	68·5
16.0	17	27·5	100·5	82·0	60·5	68·0

SUMMARY AND CONCLUSIONS

The following is a brief summary of some of the main conclusions and deductions :—

(1) The economical water velocity through the condenser tubes, size of condenser, quantity of circulating water, and size of tower, are each determined independently of the others and depend on cost ratios. The results are given in Figs. 1, 2, 3, and 6. The cost ratio for determining the size of the condenser is, however, affected by the water velocity.

* North-East Coast Institution of Engineers and Shipbuilders, March 28th, 1941.

[14] Because the economical cost indicated by Eq. (4A) for a given velocity is $2\sqrt{Z'_S Z_T W\frac{R}{m}}$.

[15] *Ibid.*

(2) The economical ratio of water to surface in the condenser is also dependent on a cost ratio, and is shown in Fig. 7. Fig. 7 shows the corresponding product of the number of passes and length of tubes, assuming the water velocity is 5ft. per second.

(3) The effect of deposit in the tubes can only be counteracted by increasing the tube surface and reducing the water velocity. There is no advantage to be gained by increasing the quantity of circulating water.

(4) The economical load on the condenser for dirty conditions should be about 5300 B.Th.U. per square foot for base load stations, instead of 7000 B.Th.U. per square foot as generally recommended.

(5) Where the size of the turbine house has been already determined, the cost per square foot of condensing surface will be reduced considerably. From Figs. 1 and 2 it will be seen that this condition justifies the use of larger condenser still and lower water velocities. The only limitation will probably be the condenser space available in the building. Practically speaking, this will mean that where the size of the building is fixed, it pays to install the largest condenser possible into the space available, but not by reducing the pitch of the tubes but by increasing the overall dimensions.

(6) For 1in. diameter tubes of normal dirtiness the number of passes for tidal river cooling and for cooling tower should be at least three, with a tendency for four passes for smaller machines. For very short circulating water systems and large machines a single pass is justified.

(7) Bearing in mind the cost of the circulating water system and the cost of pumping, the longer the circulating water system is, the more the quantity of circulating water should be reduced, and the lower should be the normal vacuum in the condenser.

(8) Subject to the ground being suitable to bear the weight, power stations using tidal river water

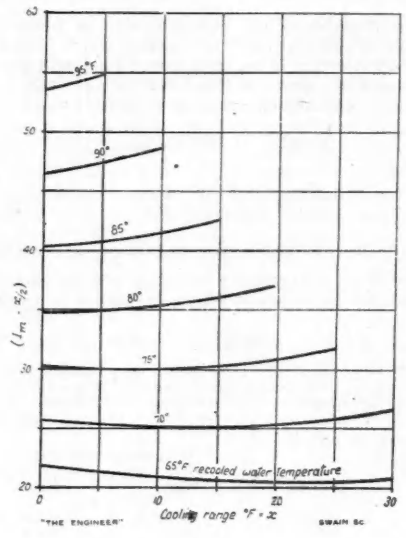


FIG. 12.—*Cooling Tower Data*

cooling should be placed as near as possible to the river front, in order to reduce the length and cost of the circulating water system and also to improve the overall efficiency of the station. By placing the station on the river front a saving of 1 per cent. in the fuel consumption can be effected without reducing the distance between the intake and the discharge to the river compared with a station placed about 800ft. from the bank.

(9) The economical size and performance of cooling towers indicated in Fig. 6 will have some bearing in making comparisons between cooling tower and river water cooling schemes. A comparison of this nature is outside the scope of this paper because the effect on the transmission system has to be considered.

(10) In tidal estuary water schemes, where the average temperature is 60 deg. Fah., due to recirculation in the river, it is uneconomical to design for the same normal vacuum as for river water schemes where the average temperature is 55 deg. Fah.

(11) For a typical base load station with cooling towers, the economical loading of the towers should be 14,000 B.Th.U. per square foot of base area, with a cooling range of 14 deg. Fah. The economical rainfall at the tower base should therefore be 100 gallons per hour per square foot of base area.

ACKNOWLEDGMENTS

The author desires to express his thanks to Messrs. Merz and McLellan for the necessary facilities and assistance in the preparation of the paper, and to Lieut.-Colonel Woodward, M.C., T.D., general manager of the North-Eastern Electric Supply Company, for permission to produce data showing the performance of the condensers at Dunston "B" power station.

The author also desires to express his thanks to Mr. T. E. Daniel, M.Eng., borough electrical engineer for Darlington, for permission to produce the results of the cooling tower tests.

APPENDIX

ALTERNATIVE METHOD OF DETERMINING THE ECONOMICAL WATER VELOCITY IN THE CONDENSER

In the general economic theory given in Section I the water velocity in the condenser was not treated as one of the independent variables, but was assumed to be fixed. The economical loading of the condenser, as given by Eq. (4A), applies to any water velocity, and from this, Eq. (22) was deduced, giving the economical velocity.

We can, however, make the velocity an additional independent variable in Eq. (1) and by pursuing the same line of reasoning as before the following is added to Eq. (3):

$$Z_v + Z_P \frac{\delta P}{\delta v} + Z_T \frac{\delta_P}{\delta v} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3D)$$

which gives the general condition to be satisfied for the economical velocity.

But Z_v is nil,

and

$$\frac{\delta_P}{\delta v} = \frac{3}{v}\left(\frac{v}{36}\right)^3 S \text{ by Eq. (20)}$$

also

$$\frac{\delta T}{\delta v} = -\frac{W}{S \cdot m} \cdot \frac{R_1}{v^2} \text{ by Eqs. (13) and (8).}$$

Substituting these values in Eq. (3D) and putting $Z_T = W Z'_T$, we have

$$3v\left(\frac{v}{36}\right)^3 = \frac{Z'_T}{Z_P} \cdot \frac{R_1}{m}\left(\frac{W}{S}\right)^2 \quad . \quad . \quad . \quad . \quad (29)$$

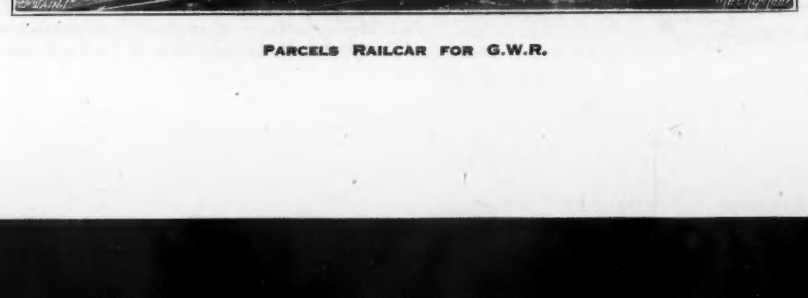
which gives the value of the economical velocity for any loading of the condenser surface W/S.

When W/S is the economical loading, as given by Eq. (4A), then Eq. (29) becomes the same as Eq. (22).

Parcels Railcar for G.W.R.

THE second of the oil-engined parcels railcars of Associated Equipment Company design for the G.W.R. will shortly go into service. It is illustrated herewith. This car is part of the fleet of twenty railcars, passenger and parcels, of revised design, which will supplement those now running on different parts of the G.W. system. When completed they will bring the railcar fleet up to thirty-eight units. The G.W.R. introduced the first parcels car in this country on to its system in 1936. It was primarily placed in service to reduce passenger train delays caused by the handling of parcels at intermediate stations, and it has continued to work regularly ever since. The parcels railcar illustrated embodies all the improvements which have been made since the first single-engined car began running in the London area, and which were described in THE ENGINEER in our issue of May 17th and May 24th, 1940. They include twin engines of more efficient type with better cooling arrangements; radiators placed behind the engines and fitted with intermediate header tanks for de-aeration; bevel drive axle-boxes incorporating reverse gear, two-tread brake shoes on each wheel in place of the internal expanding type, and electro-pneumatic controls with a wiring system arranged for good accessibility. The control system is designed to give definite movements for all motive power equipment under the driver's direction, irrespective of the air pressure available. By the use of an ingenious pre-selector motor five positions are obtained with only three magnet valves. Both these and other control valves are grouped in an accessible position at the side of the car. Motive power is obtained from twin A.E.C. six-cylinder, direct injection engines, having a bore and stroke of 120 mm. by 142 mm. and giving a combined output of 210 B.H.P. at 1650 r.p.m. They include an oil cooling system using water-cooled grids in the main sump. The transmission system incorporates a fluid fly-wheel, five-speed epicyclic gear-box and bevel type final drive with reverse in the inner axle box of each bogie. The outer axle, also bevel driven, is connected to the inner axle by a cardan shaft, thus giving a drive on all wheels.

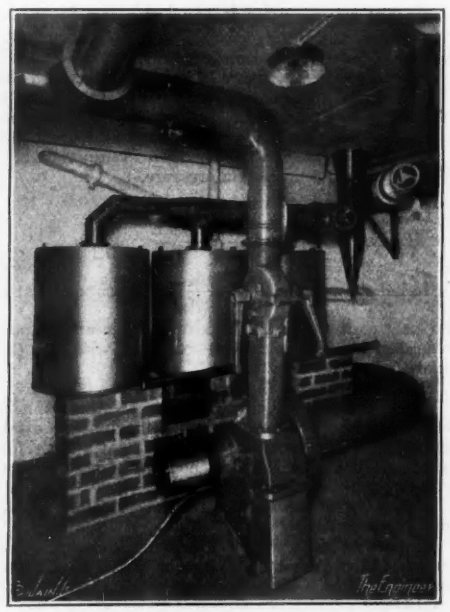
The new car has the exterior design of body standardised for the new fleet. In this the curves and rounded surfaces of early "streamliners" have been replaced by straight lines and flat panels. The roof, formerly elliptical, now comprises a series of flats. At least 2ft. in body space have been gained by the adoption of an almost straight front instead of a rounded, downswept structure, and a further foot has been obtained by carrying the body over the headstocks at each end. These are now of standard railway type with screw couplings and vacuum brake pipe connections for use with hauling trailer coaches. Six double doors give access to the interior which has a floor space of approximately 450 square feet. Five folding, slatted shelves are fitted at each side, and there are seven roof lights for night work. The car can carry 10 tons of parcels.



PARCELS RAILCAR FOR G.W.R.

Ventilation System for Air Raid Shelters

IN an article which was published in our issue of December 13th, 1940, we described a reinforced concrete air raid shelter, termed the "Raidsafe" shelter, which is designed and manufactured by Andamite, Ltd., of 52, Ebury Road, London, S.W.1, and in our later issue of April 25th we were able to inform our readers that in response to the approach of the Ministry of Aircraft Production the "Raidsafe" shelter had been redesigned and approved for



VENTILATING PLANT FOR AIR RAID SHELTER

use as a fire-watcher's post. In the design and installation of these shelters the company was faced by the essential problem of an efficient system of ventilation and air purification for air raid shelters in view of possible gas attacks, and on Thursday, June 26th, we attended, at the firm's London office, a demonstration of the new type of ventilation and air purification plant which has been evolved and is now manufactured by the firm in four standard sizes, which have been approved by the Home Office and have a capa-

city on by-pass of 15,000 to 60,000 cubic feet of air per hour, on filters of 3750 to 22,500 cubic feet per hour, and are designed to suit accommodation for 25, 50, 100, and 150 persons, allowing 150 cubic feet of air per person. We have given the air quantities for the smallest and largest sizes of plant, and in the accompanying engraving we illustrate a 150-person plant, which was recently supplied to the Walsall Corporation.

In meeting the problem presented, it was decided to provide a system of stream ventilation, giving an adequate quantity of fresh air delivered to every part of the shelter or building, with the effective exhaustion of the stale and humid air. In the event of a gas attack, filters are provided which can be brought into circuit in such a manner that they deal only with contaminated air. In gasproof shelters it was decided to provide an over-pressure or plenum, so that should such a shelter crack under bombardment the over-pressure would still provide protection against the possible infiltration of gas.

The plant comprises an impeller unit, both electric and manually operated, designed to work against a high static resistance, gas-tight valves to control the flow of air, with the necessary measuring instruments, for pressure and volume, and a system of filtration designed to deal with all known war gases.

The Impeller Unit.—The air impeller unit will be seen in the forefront of our engraving and it is made in four different sizes. It consists of a centrifugal impeller which is driven at a speed of 2850 r.p.m., has curved forward blades and is statically and dynamically balanced. Owing to its high speed and special design, the impeller is capable of delivering its rated output against a total resistance of 8in. W.G. It is contained within a strong cast iron casing, so shaped as to ensure a high air velocity. The impeller shaft is directly coupled to a high torque electrical motor, and is also connected through a train of gears to a shaft which extends beyond the casing, to which crank handles can be fitted in case of electric supply failure. The gears run in an oil bath, and all shafts are carried in ball bearings. When manually worked we found the gearing smooth running and easy to operate, with either one, or better two handles.

Air Control Arrangements.—For the control of the volume of incoming air, a throttle valve is employed with a second similar valve, which controls the gas filter by-pass system. The valves are made in four different sizes. The outgoing air passes through a non-return valve or over-pressure valve. It comprises a metal disc which has a ground metal face closing on to a ground metal seating. The disc is carried on a counterbalanced arm, the weight of which can be adjusted in order to allow the valve to operate between the pressure limits of $\frac{1}{4}$in. and $\frac{3}{8}$in. W.G. Provision is also made for locking the valve in the shut position should the necessity arise.

For spreading the incoming air evenly to all parts of the shelter with absence of draught, a neat design of distribution valve is employed, which is made in three sizes, and is capable of adjustment to deliver the required quantity of air. For controlling the flow of air from one room or compartment to another, or in the case of a gasproof shelter into the air lock, a rosette valve is used, which consists of two metal discs furnished with apertures, which, on twisting by hand, can be opened or closed as may be required. The surfaces in contact are ground, and when shut the valve is fully gas-tight.

For measuring the correct quantity of air being delivered, an aerometer, with a light aluminium bobbin moving in a graduated tube, is employed. The position of the bobbin in the tube indicates the quantity of air being delivered. A pressure gauge of the ordinary membrane type shows the difference between the air pressure within and without the shelter. This gauge is, we noted, particularly sensitive, and is calibrated to register a pressure difference as low as $\frac{1}{4}$in. W.G.

Air-filtering Arrangements.—For the purification of the entering air, three measures are taken—a preliminary dust filter, a condensation trap, and the main gas filters. The dust filter is placed at the top of the external inlet pipe, and consists of a tightly wound coil of fine gauge expanded metal pressed into a housing. The condensation trap is situated conveniently in the intake ducting, and allows any moisture which collects to be drawn off through a cock before reaching the filter. The gas filters are made in two sizes, which comply in every respect with Home Office requirements. The principles involved in the construction of the two sizes are the same throughout, embodying two portions contained within one heavy steel drum. The incoming air first passes through a thick layer of asbestos merino wool which removes all greasy smokes and arsenical irritants. The air is then drawn through closely packed activated carbon in the form of small granules, which absorbs all known war gases. The interior of the filters is protected with an anti-corrosive compound, and the arrangement ensures that the resistance is such that the air is evenly distributed throughout the filter.

U.S.A. PLASTICS COMBINE.—Some of the larger manufacturers in America have formed the Plastic Materials Manufacturers' Association in order to facilitate co-operation in the utilisation of such materials.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Iron and Steel in the United States

The active conditions ruling in the United States appear likely to last for a long time and the trade there has made up its mind for months of prosperity. The production of pig iron in May is placed at 4,600,000 tons, compared with 4,334,267 tons in April. There were 205 blast-furnaces operating on June 1st, compared with 195 on May 1st. A furnace in the Birmingham district closed down during June for rebuilding, and it is expected that its capacity will be increased from 675 tons to 1000 tons daily. Furnaces that have long been idle have been recommissioned and in the case of these the aggregate production will add 45,000 tons to the monthly output. It is suggested that in some cases quotations against inquiries on British account have been somewhat in excess of the domestic prices. It is believed that the big increases in steel-making capacity in the United States, which has been pressed upon the industry by the authorities at Washington, will require an increase in the production of pig iron of at least 1,000,000 tons per annum. This estimate does not take into account the increase in the pig iron producing capacity of the country by furnaces which are at the moment under construction. Pig iron prices have not been changed from those quoted for delivery during the first half of the year, but there are reports that an increase of 1 dollar may be made on pig iron prices for the third quarter delivery. Careful distribution by the producers has kept consumers well supplied with pig iron, and there has been no instance reported of foundries having been obliged to shut down through lack of raw material. The production of steel has increased to an average for the trade of 99·2 per cent. of steel ingot capacity. In the Pittsburg district the industry is operating at 101 per cent. of capacity and the Bethlehem Steel Corporation plants are working at 103·7 per cent. Most of the heavy rolled steel mills, the plate mills, the structural steel mills and the sheet and strip mills are sold forward into 1942. The railway companies recently came into the market and orders have been placed for 5500 freight cars and there are additional inquiries for another 15,000. One railway has ordered 12,000 tons of rails and in addition to another 1000 freight cars now under order has contracted for a further 2000. In order to conserve steel it has been suggested that wood should be more extensively used in constructing freight cars in the future.

The Pig Iron Market

Considerable interest is taken in all sections of the market in the possibility of an advance in prices. No official hint, however, has been forthcoming and traders are left to form their own conclusions. Naturally, under these circumstances, all business that has been transacted is at the prices ruling at the date of despatch of the pig iron from the works. There is little difficulty in placing orders once the necessary authorisation has been obtained, and business has been done for delivery in July and onwards. The demand for high-phosphoric pig iron from the light castings industry has again declined, but this has made little difference to the position, since this class of iron is now being used under persuasion of the Control by many consumers as a substitute for low-phosphoric and hematite. The bulk of low-phosphoric iron now comes from the blast-furnaces in Northamptonshire and Derbyshire, but deliveries have been well maintained, the producers apparently are not finding it difficult to supply consumers over a much wider radius than is usual in peacetime. The distribution of hematite pig iron has been restricted, although it is understood that this will be only for a time. The Control, however, is carefully scrutinising licences and has rationed the consumption. For the time being practically all sales are for prompt delivery and makers have been requested not to enter into forward contracts. Expectations that the prices of this class of iron will be increased have been strengthened by the recent advance in the quotation for hematite ore, and a limitation of imports. For some time it has been expected that an increase would be made in the price of blast-furnace coke. A short time ago the price of industrial coke of other descriptions was raised, but it was not until this week that the official quotation for blast-furnace coke was advanced by 1s. 3d., making the quotation for best Durham coke 38s. 9d. at ovens. The position in the basic pig iron department is satisfactory and production is at a high level.

Scotland and the North

Active conditions prevail at the Scottish steel works. Practically all the iron and steel plant which it has been possible to bring into operation is now at work in Scotland and outputs have reached a high level. A very large proportion of the work is on Government account and nearly all of high-priority category. Consumers who do not come within this definition do not find it easy to obtain supplies of steel. The works are heavily booked and it is almost impossible to place orders for delivery during the current month, but a good tonnage of business has been accepted for the second delivery period, which commences on July 1st. It is evident that the producers will be fully employed over this period and until later in the year, in fact, the indications are that there is not likely to be any relaxation in the demand for a long time. The heavy steel makers have full order books and are operating nearly at capacity. There is still a rather quiet demand for heavy joists and structural material, but the request for plates is unabated and large tonnages are passing through the shipyards to boilermakers, tank makers and wagon builders. Business in light joists and constructional material has been maintained at capacity levels for many weeks and there is no sign of the demand slackening. All the re-rolling works are fully occupied and for some time past they have had adequate supplies of raw materials in the shape of billets to meet their requirements. The outputs are passing into consumption, but distribution is carefully supervised by the Iron and Steel Control and consumers engaged upon war work and other priority users obtain steady and regular deliveries. In the Lancashire district the demand for steel appears to be expanding. The engineering works, practically all of whom are employed in the war effort, are large buyers of special steels. There is a particularly keen request for nickel and nickel-chrome steel. Some of the special steels which are now being distributed to consumers are of American origin, but the British production is on a heavy scale and the consuming works are well supplied. There is also an insistent call for steel bars and bright-drawn steel bars are wanted by the engineering trades. Sheet makers are also engaged largely upon Government work.

Copper and Tin

The position of the copper market in Great Britain has shown little variation from that ruling for many weeks. Supplies are adequate to enable the war industries to operate at a high rate of capacity and there are no reports of firms being inconvenienced by having to wait for their deliveries. The war industries are using heavy quantities and naturally the Control keeps a watchful eye over the distribution. For this reason there is difficulty in getting metal for work which is not regarded as essential to the war effort. In the United States large quantities of copper are passing into consumption in the armament programme. Export business, however, is practically impossible and offers which have been made to American producers for copper for export have been almost invariably turned down. Prices in the United States are unchanged at 12c. for the home market and 11c. nominal for export. So far the war in Russia does not appear to have affected the copper market, but it is anticipated that before long the Russian requirements of copper and some other non-ferrous metals will be on a substantial scale. Russia has been a buyer of copper until comparatively recently, when the United States showed a reluctance to accept orders from that country. Her own production of copper is believed to be less than 100,000 tons per annum, although actual statistics on this point are not available. In the United States the distribution of copper is completely under control and metal imported from Chile is now being distributed by the Office of Production Management. . . . The tin market has the appearance of being rather tight and the issue of export licences is still held up. It is generally assumed that it is the intention of the Government to build up stocks of tin in this country. Russia is expected to require considerable quantities of tin and, it is believed, will look to the British Empire to furnish supplies. It is not expected, however, that export licences for ordinary overseas business will be issued for some time. The chief feature of the market is the development of a contango of £3, but this is regarded as more healthy than a backwardation and, in fact, it is pointed out that there is no adequate reason why a backwardation should develop as the stocks in this country should be sufficient to satisfy the requirements of consumers.

Lead and Spelter

In Great Britain the lead position is satisfactory and supplies appear to be reaching this country with regularity. The distribution is well looked after by the Control and consumers engaged in the war industries are obtaining their full requirements. In fact, the position is easier than in the case of other non-ferrous metals. Naturally, consumers who are not engaged in essential work are rationed, but their supplies are not so seriously affected as in the case of other metals. The United States market is rather tight and stocks are at an unusually low level. . . . Somewhat tight conditions prevail in most of the world's spelter markets. In the United States there is no metal for export, although efforts have been made by a number of neutral countries to obtain supplies. Not long ago Japanese bids were made in the United States up to £80, but the metal was not forthcoming. Within the last few days bids equivalent to £60 per ton have been received for spelter from neutrals, whilst the official price in the United States stands at 7¼c. This includes the duty and is roughly equivalent to £40 per ton. Considerable quantities of spelter are required by the American defence programme, but the necessary supplies appear to be forthcoming.

Non-ferrous Metal Prices

The London Metal Exchange official statement for June again indicates a slight decline in the average quotations of tin of £4 6s. 5d. for cash and £1 17s. 7d. for three months, compared with the May average. The settlement average is £4 17s. 3d. below that for the previous month. The statement, which includes the official maximum prices for copper, lead and spelter, is as follows :—

Standard tin	Cash (mean)	£262	17 6
	Three months (mean) ...	£264	11 4¼
	Settlement	£262	17 0

The following prices for copper, lead and spelter are the maximum prices fixed by the Controller of Non-ferrous Metals :—

	£	s.	d.	
Standard copper				
Electrolytic copper ...	62	0	0	delivered buyers' premises
Electrolytic wire bars ...	62	0	0	,, ,, ,,
Best selected copper ...	60	10	0	,, ,, ,,
Lead, good soft pig ... (foreign)	25	0	0	,, ,, ,, (duty paid)
Spelter, G.O.B. (foreign)	25	15	0	delivered buyers' premises (duty paid)

Notes and Memoranda

Rail and Road

LEMAN STREET AND SHADWELL STATIONS, L.N.E.R.—The London and North-Eastern Railway states that from July 7th Leman Street and Shadwell stations, London, will be closed.

BOSTON, U.S.A., COALING STATION.—A contract has recently been placed for the construction of a locomotive coaling station and a sanding station for both steam and oil-engined locomotives at Dover Street, Boston, Mass.

AMERICAN RAILWAY EMPLOYMENT.—Preliminary reports from the Interstate Commerce Commission show that during April employment on the American railways increased 2·91 per cent. to 1,080,896. This is 9·73 per cent. above the figure for April, 1940.

AMERICAN FREIGHT CAR REQUIREMENTS.—The Association of American Railroads has recently suggested that 120,000 additional freight cars will be required to handle traffic during 1942 and a further 150,000 for 1943. This programme is additional to increased orders for 1941 delivery.

MANCHESTER'S GAS-DRIVEN BUSES.—It is expected that gas-driven buses will shortly be in service on the Old Trafford circular route of the Manchester Corporation transport department. Arrangements are being completed for the provision of gas-filling stations along the route, and if the experiment proves successful, gas-driven buses may be introduced on other routes.

SWISS RAILWAY ELECTRIFICATION.—The electrification of the Lucerne and Meiringen section of the metre gauge Brünig line is expected to be completed by the autumn of this year, according to the *Railway Gazette*, and the level section from Meiringen to Interlaken is to be converted by the spring of 1942. In view of the higher speeds which will be permitted, new signalling is being installed, with both home and distant signals mostly of colour-light type. The permanent way has been improved, and curvature reduced at various points, in one instance (near Giswil) by an entire relocation of the line.

CHESAPEAKE AND OHIO LEVEL CROSSINGS.—Six level crossings on the lines of Chesapeake and Ohio Railway were replaced by overbridges or underbridges during the year 1940, and flashing light signals were installed to protect level crossings at eight points. The company has also arranged contracts with highway-departments of several of the States traversed by its lines for other important level crossing elimination projects, and it is expected that construction work will begin in the early spring of next year. Contracts have also been entered into for flashing light signals at a number of additional highway level crossings.

G.W. RAILWAY ACCIDENT.—It is with deep regret that we have to record a serious railway accident on the Great Western Railway near Slough early on Wednesday morning, July 2nd, which resulted in the death of five persons and injury to twelve others. The express, which was due in at Paddington about 3 a.m., was running on the main up line. It had just passed through Slough Station when it collided head-on with a goods train at a set of cross-over points near Dolphin Bridge. The first two coaches of the express were telescoped, and it was in them that most of the casualties occurred. The trucks of the goods train were piled up behind its engine. Its driver was among the injured.

JAPANESE ELECTRIC LOCOMOTIVES.—Several electric locomotives for passenger, freight, and shunting duties have been built within the last eight or nine years for the Japanese Government Railways by Japanese firms, principally to designs and detail drawings prepared by the Ministry of Communications. The *Railway Gazette* states that in general the designs were based on the locomotives supplied by English Electric and Brown-Boveri in the years after the 1914–19 war, and all are for service on the standard 1500-volt D.C. system with overhead current collection and 3ft. 6in. gauge tracks. One of the leading express passenger types is classified EF 56, and has the 2–Co+Co–2 wheel arrangement. The weight is 109 tonnes and the overall length 65½ft., but the one-hour rating is only 1810 H.P. The top service speed is limited to 60 m.p.h., and an oil-fired boiler is installed for steam heating the train. Another passenger type, for use on heavily graded routes, is of the 1–Co+Co–1 lay-out, and is classified EF 11. The one-hour output is the same as that of the "EF 56" class, but the top speed is limited to 40 m.p.h., and regenerative braking equipment is incorporated. The working order weight is 97½ tonnes, and the overall length 57½ft. Within recent years semi-streamlined four-car multiple-unit trains have been introduced in the electrified areas round Tokyo, Yokohama, and Kobe.

Air and Water

THE LIFEBOAT SERVICE.—The Royal National Lifeboat Institution records that during the first twenty-one months of the war lifeboats rescued 3816 lives, an average of 42 per week.

LOSS OF H.M.S. "GRIMSBY."—The Board of Admiralty announces with regret the loss of H.M. sloop "Grimsby." She was of the escort type, completed in 1933, with a displacement of 990 tons and a complement of 100.

WHARF BUILT IN TWELVE DAYS.—Particulars are given in *Engineering and Contract Record* of a small wharf built at Stoney Point, Ontario, on the south shore of Lake St. Clair. The length of the wharf is 120ft., averaging 35ft. in width. Approximately 700 lineal feet of round timber were needed for the piling, which was driven to a depth of 12ft. below the ground level, in rows 10ft. apart, and spaced at 10ft. centre to centre. Square timber beams, 6in. by 10in., spanned the piles, on which were laid the 6in. by 10in. stringers, spaced at 3ft. centres. The flooring was of 3in. planking. Sheet piling was driven along the shore side of the wharf as a protection against wave action. The work of driving the piles was completed in six working days, and the whole work took only another six days for completion.

CANADIAN AEROPLANE ORDERS.—The Canadian Munitions Minister has announced that an order has been placed with the National Steel Car Corporation for Martin B 26 twin-engine bombers. They weigh 13 tons. It is understood that the order is for 200.

DRY DOCK AT MOBILE.—An 18,000-ton all-steel dry dock for the Todd-Galveston Dry Docks, Inc., is to be built at Mobile, Ala., by the Alabama Dry Dock and Shipbuilding Company. The cost is estimated at 1,500,000 dollars, and the dock will be electrically operated. The project will, it is anticipated, require ten months for completion.

VANCOUVER DRY DOCK.—Plans have been completed for the construction of a new dry dock by the Burrard Dry Dock Company, Ltd., to supplement the dock at present owned and operated by the company. The new dock will be big enough to handle all ordinary deep-sea freighters, and is expected to be in operation within twelve months. Its estimated cost is 600,000 dollars.

CANADIAN SHIPBUILDING.—It is reported that shipbuilders of the Clyde and other shipyards in Britain are to go to Canada to help speed the Dominion's merchant shipbuilding programme. Orders amounting to 175,000,000 dollars for ninety-six merchant ships of 10,000 tons each, to be completed before the end of 1943, are to be placed at Canadian shipyards on the Pacific Coast and St. Lawrence River.

PORT CREDIT WATERWORKS, ONTARIO.—In order to increase the capacity of the existing waterworks equipment, the town of Port Credit, Ontario, has placed a contract for an extension of the existing water intake. The work calls for the laying of 500 lineal feet of piping from the end of the present pipe farther out into Lake Ontario. The present water supply system of the town was built in 1923, and since that time no additions of any kind have been made. The distribution system has been extended in the past at intervals, and the plant has functioned normally with a daily average consumption of 125,000 gallons. The increase of residential construction has recently created a larger demand, running on an average daily consumption of 235,000 gallons, with a maximum peak for periods extending over several hours of over 500,000 gallons per day. The original plant was designed for a capacity of 300,000 gallons. The present scheme for increasing the supply is to improve the quality of the raw water so that the existing pumps, filter beds, and storage tank will not have to be increased in capacity. The present heavy draw on the intake has been instrumental in causing the raw water to become turbid, taxing the filters to the limit. By extending the intake pipe farther out into the lake, the clarity of the raw water will be improved, and thus relieve the strain on the filters.

Miscellanea

CANADIAN TUNGSTEN.—The Canadian Government is investigating the extent of the tungsten ore deposits recently discovered at Gilmore Lake, and which have assayed 57·61 per cent.

S.A. CORUNDUM.—Corundum deposits recently discovered at Marandellas and Rusapa in Southern Rhodesia have been taken over by the Gifter Corundum Company, of South Africa, which will develop production on an increased scale.

INDIAN CHROME ORE.—The State of Mysore is one of the principal sources of Indian chromite, contributing nearly 50 per cent. of the total output—15,000 to 30,000 tons annually. Many large chromite deposits exist in the State, but at present only the higher-grade ores are being worked.

HARD GLASS FOR LAMPS.—An American electrical company has introduced a series of high-wattage industrial lamps much reduced in size and made with weatherproof glass to withstand thermal shocks. Use of a hard glass bulb has made it possible to produce a 500-watt lamp no bigger than the ordinary 200-watt lamp.

CHROME IN S.A.—The South African Department of Mines and Public Works has asked both large and small producers of chrome to accelerate the effort to meet war requirements. Chrome Producers (Rhodesia), Ltd., representing the small workers, has received assistance from the Government enabling the company to make advances to its members for production and sale.

FOR HAWAII.—The Westinghouse Company of America has been awarded a contract for the largest turbine generator in Hawaii. The unit will be a 35,000-kW hydrogen cooled tandem machine. The 3600 r.p.m. generator will have a new type of flexibly mounted stator core, similar to that utilised recently for large turbine generator units. It will be the only hydrogen cooled machine on the islands.

THE INSTITUTE OF PHYSICS.—At the annual general meeting held recently at the University, Reading, Professor Sir L. Bragg was elected President. The report disclosed a wartime demand for trained physicists with the supply inadequate. The Ministry of Labour and National Service is taking all possible steps to ensure that the flow of training physicists through the universities and technical institutes shall be maintained.

ELECTRIC PIG FARMING.—American electrical interests are trying to get farmers to install an electric pig brooder that can be built at home at a cost of less than 10 dollars. Farmers have found that by using the brooder pigs can be safely farrowed earlier in the year, usually late February or early March, and brought on the market in August, when prices are best. An outfit comprises a three-sided, covered board shelter, with one side open, which can be installed in the corner of the sty. A 150-watt lamp with reflector fitted in the top of the shelter supplies the necessary heat.

EXPORT CONTROL.—Under a Board of Trade Order, which comes into force on July 10th, 1941, licences will be required to export to all destinations mine and well-drilling machinery. The Order also prohibits the export without licence to certain specified destinations of mining drill bits and extends the existing prohibitions in respect of shellac, seedlac, sticklac, and other varieties of these lacs; plywood, including laminboard, blockboard, and battenboard; bentonite and casein.

COAL IN EIRE.—An order has been introduced by the Eire Government prohibiting any more motor vehicles from being fitted with town gas containers. The reason given is coal shortage. Some time ago the gas companies issued a statement pointing out that the consumption of gas by road vehicles was comparatively a very small percentage of their total output. Meantime the public is in no hurry to register with the coal merchants under the Eire coal rationing scheme, despite the official intimation that householders should do so as soon as possible.

MERCURY AGAIN.—The search for mercury continues. The Yamato Mercury Mining Company, of Japan, is planning to increase its output of quicksilver. Japan is not a big producer of the metal, her production, according to market estimates, fluctuating between 1500 to 2000 flasks annually. A cinnabar deposit is being developed in the Bubi district of Southern Rhodesia with Government assistance, according to the S.A. Department of Mines and Public Works.—The U.S. Bureau of Mines reports that domestic production of mercury during March amounted to 3500 flasks, against 2900 flasks in February. The rise in output is understood to have accompanied more favourable weather conditions, particularly in California.

Personal and Business

MR. WALLACE C. DEVERAUX has been appointed Controller of North American Aircraft Supply, Ministry of Aircraft Production.

MR. P. D. TROSKIE has been appointed Chief Traffic Manager at the Johannesburg headquarters of South African Railways and Harbours.

BARIMAR, Ltd., announces that its address is now Kent House, 22–24, Peterborough Road, Fulham, London, S.W.6 (telephone, Renown 2147).

MR. W. J. JEFFERY has retired from the position of chief engineer of the Charing Cross and City District of Central Electricity, Ltd., after forty years' service with that undertaking. His successor is Mr. R. N. Pegg.

THE ROYAL AERONAUTICAL SOCIETY has elected Mr. Griffith Brewer President for the year 1941–42, and Professor L. Bairstow, Mr. W. C. Deveraux, and Lieut.-Colonel the Right Hon. J. T. C. Moore-Brabazon have been elected Vice-Presidents.

MR. J. C. ORKNEY, who has been head of the electrical engineering department of Robert Gordon's Technical College since 1927, has been appointed Associate Professor of Civil and Mechanical Engineering and Applied Mechanics at the Royal Technical College, Glasgow.

WE note with regret the death, on June 10th, of Mr. Robert Pooley, London manager of the Shelton Iron, Steel and Coal Company, Ltd. Mr. Pooley was sixty-seven years of age and joined the firm of Livesey and Henderson in 1889. He went to the Shelton Company in 1911.

L.N.E.R. APPOINTMENTS.—The directors of the London and North-Eastern Railway have authorised the following appointments:—Mr. R. J. M. Inglis, engineer, Southern Area, to be divisional general manager, Scottish Area; and Mr. J. C. L. Train, engineer, Scottish Area, to be engineer, Southern Area.

THE STAVELEY COAL AND IRON COMPANY, Ltd., announces the retirement of its chairman, Sir William Bird. He will be succeeded by Mr. D. N. Turner, the present managing director. Mr. H. H. Berresford is to become managing director and Mr. T. A. McKenna is to be appointed commercial manager.

THE AUSTIN MOTOR COMPANY, Ltd., announces that Mr. E. L. Payton, J.P., deputy chairman and financial director, has been appointed chairman of the company in succession to the late Lord Austin. Mr. Payton was elected to the board in April, 1922. In July, 1927, he was appointed to the committee of management, and became deputy chairman of the company in November, 1928.

MR. JOHN BRASS has been appointed Acting President and Chairman of the "Emergency" Executive Committee of the Institution of Mining Engineers, pending the election, when circumstances permit, of a President in succession to the late Mr. E. O. Forster Brown. Mr. Laurence Holland, Hon. Treasurer, has been appointed Vice-Chairman of the "Emergency" Executive Committee.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Civil Engineers

Saturday, July 12th.—YORKSHIRE ASSOC.: Hotel Metropole, Leeds. Luncheon. "The Lennox Road Refuse Disposal Station," W. S. Cameron. 1 p.m.